Engineering Library
SEP 14 1917
UNIV. OF MICH. LIBRARY

ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND B. ALFRED RAWORTH.

OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 35 & 36, BEDFORD STREET, STRAND, LONDON, W.C. 2

VOL. CIV.—No. 2693.] *LONDON: FRIDAY, AUGUST 10, 1917.* [*Registered at the General Post Office as a Newspaper.*] PRICE 6d. BY INLAND POST...10d.

Aveling & Porter, Ltd.,
ROCHESTER, KENT,
and 73, CANNON STREET, LONDON.
STEAM ROLLERS. ROAD LOCOMOTIVES.
STEAM CULTIVATING MACHINERY.
STEAM WAGONS. TRACTORS.
CEMENT-MAKING MACHINERY. 6030

A. G. Mumford, Ltd.,
CULVER STREET WORKS, COLCHESTER.
OF ADMIRALTY AND WAR OFFICE LISTS.
ENGINES for Torpedo Boats, Yachts, Launches, BOILER FEED PUMPS.
See Advertisement, page 23, last week.
PATENT WATER-TUBE BOILERS,
AUTOMATIC FEED REGULATORS.
And Auxiliary Machinery as supplied to the Admiralty. 2179

Two Motor-Generators, Westinghouse. Motor three-phase, 50 periods. Generator 500 volts.
One A.C. Motor 300 HP., three-phase, 50 periods.
One D.C. MOTOR or GENERATOR, 575 r.p.m., 200 Kw., at 440/550 volts.
One Two-phase 200 Kw. GENERATOR, 50 periods, 2300 volts, but could be readily altered for other voltages.
JENNINGS,
West Walls, Newcastle-on-Tyne. 6048

Marine Steam Turbines
(PARSONS' PATENT). 5758
JOHN SAMUEL WHITE & COMPANY, LTD.,
Shipbuilders and Engineers,
EAST COWES, I.W.

See's Patent Hydro-Pneumatic **Ash Ejector.**
Great saving of labour. No noise. No dust. No dirt. Ashes discharged 20 ft. clear of vessel.—Apply, F. J. TREWENT & PROCTOR, LTD., Naval Architects and Surveyors, 43, Billiter Bldgs., Billiter St., London, E.C. Oct 4826

Petter Oil Engines.
Manufactured by 3691
PETTERS LIMITED, Engineers, Yeovil.
See our Illustrated Advt. every alternate week.

Craig & Donald, Ltd., Machine TOOL MAKERS, JOHNSTONE, near Glasgow.
For class of Machine Tools see our Illustrated Advertisement every alternate week. 1358

FOR
Sheet Metal Stampings or write PRESSINGS
GARTSHERRIE ENGINEERING & FORGE CO., 50, WELLINGTON STREET, GLASGOW. 5433

Steam Hammers (with or without guides). Hand-worked or self-acting TOOLS for SHIPBUILDERS & BOILERMAKERS. 5795
DAVIS & PRIMROSE, LIMITED, LEITH, EDINBURGH.

Brett's Patent Lifter Co. LIMITED.
Hammers, Presses, Furnaces, COVENTRY. 610

Bever, Dorling & Co., Ltd., BRADFORD.
HIGH-CLASS ENGINES FOR ALL PURPOSES, also WINDING, HAULING, AIR COMPRESSING and PUMPING ENGINES. 1806

Cranes.—Electric, Steam, HYDRAULIC and HAND,
of all types and sizes.
GEORGE RUSSELL & CO., LTD., Motherwell, near Glasgow. 6097

The Glasgow Railway Engineering Company, GOVAN, GLASGOW. LTD.
London Office—13, Victoria Street, S.W.
MANUFACTURERS OF
RAILWAY CARRIAGE, WAGON & TRAMWAY WHEELS & AXLES.
CARRIAGE & WAGON IRONWORK, also CAST-STEEL AXLE BOXES. 5709

Telegrams—"Cylinders," Birmingham.
Weldless-Steel Tubes for Water-Tube Boilers, Superheaters, Stalking, Hydraulic Work, Boring Rods, &c.
TUBES LIMITED, BIRMINGHAM. 3179

Yarrow & Co., Ltd.,
SHIPBUILDERS AND ENGINEERS,
GLASGOW (formerly of POPLAR, LONDON).
SPEEDS UP TO 45 MILES AN HOUR.
PADDLE OR SCREW STEAMERS OF
Exceptional Shallow Draught
VESSELS PROPELLED BY STEAM
Turbines or Internal Combustion Engines. Oct 3750

Campbells & Hunter, Ltd.
SPECIALISTS IN
Drillers & Boring Machinery
for Engine Works and Boiler Shops.
DOLPHIN FOUNDRY, LEEDS. 4547

Yachts, Launches or Barges
Built complete with Steam, Oil or Petrol Motors; or Machinery supplied. Oct 3551
VOSPER & CO., LTD., BROAD STREET, PORTSMOUTH.

Tank Locomotives
Specification and Workmanship equal to Main Line Locomotives.
R. & W. HAWTHORN, LESLIE & CO., LTD., ENGINEERS, NEWCASTLE-ON-TYNE. 5699

Cochran MULTITUBULAR AND CROSS-TUBE TYPES.
Boilers.
See page 96. 5754

Cranes.—Steam and Electric.
STEAM NAVVIES, GRAB CRANES,
SHIPS DECK MACHINERY.

John H. Wilson & Co., Ltd.
DOCK ROAD, BIRKENHEAD. 5554
London Office:—18, Victoria Street, S.W.

The Norman Thompson Flight Co., Ltd. (REGD. 1909.)
CONTRACTORS TO THE ADMIRALTY.
"THE FIRM WHO GAVE THE FLYING BOAT TO THE NAVY."
ALL BRITISH BUILT.
6165
Works:—MIDDLETON, BOGNOR, ENGLAND.
London Office:—DEWAR HOUSE, 11, HAYMARKET.
Telegrams—"Soaring, Bognor." Telephone—Bognor 62.
"Intiflyte, Charles, London." Gerrard 7329

"Gripoly"
MACHINE BELTING
FOR
Driving
—
Conveying
—
Elevating
—
SOLE MANUFACTURERS
Lewis & Tylor, Ltd.,
CARDIFF. 5484
LONDON. MANCHESTER. GLASGOW.

Iron and Steel
Tubes and Fittings.
—
The Scottish Tube Co., Ltd.,
HEAD OFFICE: 34, Robertson Street, Glasgow.

Royles Limited,
ENGINEERS, IRLAM, MANCHESTER.
FEED WATER HEATERS,
CALORIFIERS, EVAPORATORS,
CONDENSERS, AIR HEATERS,
STEAM AND GAS KETTLES, } ROW'S PATENTS.
Merrill's Patent TWIN STRAINERS for Pump Suctions.
SYPHONIA STEAM TRAPS, REDUCING VALVES
High-Class GUNMETAL STEAM FITTINGS.
WATER SOFTENING and FILTERING. 5723

Tubes, Iron and Steel.
Edwin Lewis & Sons, Ltd., Wolverhampton. 6028

Tubes and Fittings,
IRON AND STEEL.
Stewarts and Lloyds, Ltd.,
41, OSWALD ST., GLASGOW.
BROAD STREET CHAMBERS, BIRMINGHAM; and LONDON OFFICE—
WINCHESTER HOUSE, OLD BROAD STREET, E.C.
LONDON WAREHOUSE—167, UPR. THAMES ST., E.C.
LIVERPOOL WAREHOUSE—63, PARADISE ST.
MANCHESTER WAREHOUSE—34, DEANSGATE.
CARDIFF WAREHOUSE—132, BUTE ST.
BIRMINGHAM WAREHOUSES—NILE STREET, SHEEPSCOTE STREET, and 10, COLESHILL STREET.
See Advertisement page 28. 6701
THE GLASGOW ROLLING STOCK AND PLANT WORKS.

Hurst, Nelson & Co., Ltd.,
Builders of RAILWAY CARRIAGES, WAGONS ELECTRIC CARS and EVERY OTHER DESCRIPTION OF RAILWAY AND TRAMWAY ROLLING STOCK.
Makers of WHEELS and AXLES, RAILWAY PLANT.
FORGING, SMITH WORK, IRON AND BRASS CASTINGS.
Registered Office and Chief Works: Motherwell.
Cardiff Office: Gordon Chambers, 31, Queen Street.
London Office: 14, Leadenhall Street, E.C.
See Illustrated Advt. in alternate issues. Oct 3382

Rubber Stamps, Stencils,
Steel Punches, Brands, Wages Boxes, Pay Checks, Automatic Numberers and Daters for Munition Factories, &c.
Stencil Ink, all Colours, in Stock. 6062
ASH RUBBER STAMP CO., LTD.,
192, Constitution Hill, Birmingham.
Telephone—Central 788. Telegrams—"SIDASH."

R. Heber Radford, Son & Squire,
ENGINEERING, IRON AND STEEL WORKS.
Established] **Valuers,** [over 50 years.
CONSULTING ENGINEERS, REFEREES, ARBITRATORS AND PATENT AGENTS. (Senior Partner, R. HEBER RADFORD, Mem. Inst. Mechanical Engineers, Mem. Inst. Naval Architects, Mets. Iron and Steel Inst., Fellow Chartered Institute of Patent Agents.
15, ST. JAMES ROW, SHEFFIELD. 5545
Telegrams: "Radford, Sheffield." Telephone: 420.

Separators
— FOR —
EXHAUST STEAM TURBINES COMPRESSED AIR, &c.
STEAM DRYERS, METALLIC PACKINGS.
Princeps & Co.,
SHEFFIELD. 5191

P. & W. MacLellan, Limited,
CLUTHA WORKS, GLASGOW.
MANUFACTURERS OF
RAILWAY CARRIAGES AND WAGONS,
OF EVERY DESCRIPTION.
RAILWAY IRONWORK, BRIDGES, ROOFING, &c.
Chief Offices: 120, Trongate, GLASGOW. Oct 6047
Registered Offices: 108A, Cannon St., London, E.C.

CHANTIERS & ATHLIERS
Augustin - Normand
27, rue de Perrey—LE HAVRE
(France.)
3980
Destroyers, Torpedo Boats, Yachts and Fast Boats. Submarine and Submersible Boats.
NORMAND'S Patent Water-tube Boilers, Coal or Oil Heating. Diesel Oil Engines.

New Chicago Automatics,
Three Sizes. Delivery from Stock.
NEW CAPSTANS, 1¼ in. through the wire feed.
JOHN MACHAB, MARY STREET, HYDE.
Tel. No.: 75 Hyde. 6319

Yarrow Patent
Water-Tube Boilers.
4985
MESSRS. YARROW & CO. UNDERTAKE the PRESSING and MACHINING of the various parts of Yarrow Boilers, such as the Steam Drums, Water-Pockets, and Superheaters for British and Foreign Firms not having the necessary facilities.
YARROW & CO., LTD., SCOTSTOUN, GLASGOW.

John Bellamy Limited,
MILLWALL, LONDON, E.
GENERAL CONSTRUCTIONAL ENGINEERS. 1316
Boilers, Tanks & Mooring Buoys
STILLS, PETROL TANKS, AIR RECEIVERS, STEEL CHIMNEYS, RIVETTED STEAM and VENTILATING PIPES, HOPPERS, SPECIAL WORK, REPAIRS OF ALL KINDS.

RAILWAY CARRIAGES, ELECTRIC CARS, &c.
Hurst Nelson & Co., Ltd.
THE GLASGOW ROLLING STOCK AND PLANT WORKS, MOTHERWELL. Oct 3382

Matthew Paul & Co., Ltd.
LEVENFORD WORKS, **Dumbarton.** 6054
See Full Page Advt. page 58, July 27.

Head, Wrightson & Co.,
LIMITED,
—
See Advertisement page 23, Aug 3. 3409

Taylor & Challen
Presses.
6196

Railway Switches and Crossings.
T. SUMMERSON & SONS, LIMITED, DARLINGTON. 5440

G. Wilkinson & Sons,
KEIGHLEY, are OPEN to UNDERTAKE SPUR GEAR CUTTING, ¼ in. to 1½ in. pitch, and up to 4 ft. diam. Also IRON CASTINGS. Enquiries solicited. 5430

Rubber MANUFACTURERS
Hose Steam and Air Drill
GUTTA PERCHA & RUBBER, LIMITED,
Toronto Canada. 6014

Gas Engines, Suction Plants, Inspections, Tests and Reports. Expert advice.—E. J. DAVIS, M.I.Mech.E., Great Eastern Road, Stratford. Telephone: East 1956; Stratford 569. Tel.: Rapidising, London. 1794

GOLD MEDAL-INVENTIONS EXHIBITION AWARDED.
Duckham's Patent Suspended
WEIGHING MACHINES.—EAST FERRY ROAD ENGINEERING WORKS COMPANY, LTD., LONDON, E.—Hydraulic Cranes, Grain Elevators, &c.
See Mark Advt. next week, page 17. 1558

Machine Tools in Stock:—
Vertical DRILLS to admit 18 in., 26 in. and 36 in. diameter. Bolt Screwing MACHINES, 10½ in. centre Special Shafting LATHE. Second-hand PLANER, 25 ft. by 6 ft. by 6 ft.
JAMES SPENCER & CO., LTD., 4385
Chamber Iron Works, Hollinwood, Manchester.

B. & S. Massey, Ltd., MANCHESTER.
Steam Hammers, Power Hammers, Drop Stamps, Band Saws. 1604
QUICK DELIVERY. LARGE STOCK.

The Manchester Steam Users' ASSOCIATION,
For the Prevention of Steam Boiler Explosions and for the Attainment of Economy in the Application of Steam. 9, Mount Street, Manchester.
Chief Engineer: C. E. STROMEYER, M.I.C.E.
Founded 1854 by Sir William Fairbairn.
Certificates of safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers inspected during construction. 4884

£5 REWARD.

Lost on 14th July, 1917, a PARCEL containing two small walnut-wood Boxes filled with steel block gauges marked C. E. JOHANSSON, Eskilstuna.—Particulars to C. P. AND CO., 138, Goswell Road, London. H 453

University of Birmingham.
DEPARTMENT OF METALLURGY.

Professor—THOMAS TURNER, M.Sc., A.R.S.M., F.I.C.
Lecturer in Metallography—(Vacant).
Assistant Lecturer and Demonstrator—R. M. JONES, M.Sc.
The course of study covers three years, and leads to the degree of B.Sc. in Metallurgy. There are separate courses for Metallurgists and Metallurgical Chemists. Special attention is devoted to Iron and Steel; Copper, Brass and Local Industries; and to preparation for Colonial and Foreign posts. Research and other Scholarships.
For particulars, apply to
GEO. H. MORLEY, H 344
Secretary.

University of Manchester.
FACULTY OF SCIENCE.
DEPARTMENTS OF CIVIL, MECHANICAL AND ELECTRICAL ENGINEERING.

Full particulars of the Courses will be forwarded on application to the REGISTRAR.
The SESSION COMMENCES on the 4TH OCTOBER. H 435

South-Western Polytechnic
INSTITUTE, CHELSEA, S.W. 3.

UNIVERSITY and TECHNICAL DAY and EVENING COURSES in MECHANICAL and ELECTRICAL ENGINEERING commence 24th September, 1917.

Scholarship Examination, 17th September, Ten a.m.

Apprenticeship Scheme for Engineers.

Prospectus on application to the SECRETARY (Room 14).

Telephone: 809 Western. H 451

UNIVERSITY OF DURHAM.

Armstrong College,
NEWCASTLE-UPON-TYNE.

Principal—W. H. HADOW, M.A., D.Mus., J.P.

SESSION 1917-18.

COMMENCING 24th SEPTEMBER, 1917.

Departments of Mechanical, Marine, Civil and Electrical Engineering, Naval Architecture, Mining, Metallurgy, Agriculture, and of Pure Science, Arts and Commerce.

Full particulars may be obtained on application to—
F. H. PRUEN, M.A., Secretary.
Armstrong College, Newcastle-upon-Tyne. 6186

ENGINEERING AND TECHNICAL OPTICS.

Northampton Polytechnic
INSTITUTE, ST. JOHN STREET, LONDON, E.C.
ENGINEERING DAY COLLEGE.

Full Day Courses in the Theory and Practice of Civil, Mechanical and Electrical Engineering will commence on Monday, 1st October, 1917. The Courses in Civil and Mechanical Engineering include specialization in Automobile and Aeronautical Engineering, and those in Electrical Engineering include Specialization in Radio-Telegraphy. *Entrance Examination* on Tuesday and Wednesday, 25th and 26th September, 1917. These Courses include periods spent in commercial workshops and extend over four years. They also prepare for the degree of B.Sc. in Engineering at the University of London. Fees, £15 or £21 per annum. *Three Entrance Scholarships* of the value of £52 each will be offered for competition at the entrance examination in September, 1917.
TECHNICAL OPTICS.—Full and part time Courses in this important Department of Applied Science will be given in specially equipped laboratories and lecture rooms. *An Atkinson Scholarship* (value £30) will be offered in this Department at the Entrance Examination. H 461
Full particulars as to fees, dates, &c., and all information respecting the work of the Institute can be obtained at the Institute or on application to R. MULLINEUX WALMSLEY, D.Sc., Principal.

Inst. C.E. and all Engineering Examinations.—Mr. G. P. KNOWLES, B.Sc., Assoc.M.Inst.C.E., F.S.I., M.R.San.I., PREPARES CANDIDATES personally or by correspondence. Hundreds of successes, including the Bayliss Prize. Courses for next February and October are just commencing.—39, Victoria St., Westminster, S.W. Tel. No. 1402. Victoria.

STRUCTURAL ENGINEERING.

For Particulars of Course of INSTRUCTION by CORRESPONDENCE, write to "THE WESTMINSTER ENGINEERING BUREAU," 32, Old Oak Road, Acton Park, London, W. 6026

A.M.I.C.E. and A.M.I.M.E. Tuition. Also Postal Courses in Mechanical Engineering, Aircraft Design and Mathematics.—PENNINGTONS, 264, Oxford Road, Manchester.

APPOINTMENTS OPEN.

SOUTH WALES AND MONMOUTHSHIRE SCHOOL OF MINES.

Wanted, for the Duration of the War, a SENIOR LECTURER in MECHANICAL ENGINEERING and MATHEMATICS to act temporarily as Head of the Mechanical Engineering Department.
Applicants must have had workshop experience and a knowledge of mining engineering practice and must be capable of conducting testing work.
Also SENIOR LECTURER in CHEMISTRY and PHYSICS to act temporarily as Head of the Chemistry Department.
Applicants must have had works experience and a knowledge of mining chemical practice, and must be capable of conducting testing work.
Only candidates ineligible for military service need apply.
Salary according to qualifications and experience.
For further particulars apply to—
THE PRINCIPAL,
Treforest, H 226
South Wales.

COUNTY BOROUGH OF WEST HARTLEPOOL.
TECHNICAL COLLEGE.

Assistant Teacher (ineligible for military service) REQUIRED in the Mechanical and Marine Engineering Department.
Laboratory workshop and teaching experience desirable.
Salary £150 per annum.
Further particulars may be obtained from the undersigned. Applications, together with two testimonials, to be sent in before the 15th August, 1917.
J. G. TAYLOR, Secretary.
Education Offices,
West Hartlepool. H 407

MUNICIPAL TECHNICAL SCHOOL, BLACKBURN.

Lecturer Required in MECHANICAL ENGINEERING, to commence duties about 17th September, 1917.
Salary £160 to £200 per annum, according to qualifications and experience.
Applications should be sent before August 20th to the Principal, Dr. R. H. PICKARD, F.R.S., from whom further particulars may be obtained.
W. H. WHIPPLE, H 421
Director of Education.

UNIVERSITY COLLEGE OF SOUTH WALES AND MONMOUTHSHIRE
(Coleg Prifathrofaol Deheudir Cymru A Mynwy.)

Temporary Lecturer in ENGINEERING REQUIRED, Salary at the rate of £200 per annum. Appointment and duties to commence on October 1st, 1917.
Candidates must hold a University Degree or its equivalent, and possess satisfactory qualifications for taking entire charge of all Courses in the Engineering Department for First-Year Students. Further particulars may be obtained from the undersigned, D. J. A. BROWN,
Registrar.
University College,
Cathays Park, Cardiff.
July 30, 1917. H 447

DORSET COUNTY COUNCIL EDUCATION COMMITTEE.

WEYMOUTH SCHOOL OF ENGINEERING.

Applications are Invited for the Post of ASSISTANT MASTER for Afternoon Classes at the above-mentioned School, which will be opened in September next. Qualifications in Elementary Engineering Science combined with some workshop experience essential. Commencing salary £120 per annum. If the successful candidate is a capable Mechanical Draughtsman employment for his morning hours can be found with a private firm. Applications, on Forms to be obtained from the undersigned, must be sent in not later than the 10th August, 1917.
CLEMENT G. BONE,
County Offices, H 481
8th August, 1917. Dorchester.

LEYTON HIGHER EDUCATION COMMITTEE.

ENGINEERING AND TRADE SCHOOL.
Head Master, Mr. A. W. LOVERIDGE, B.Sc. (Eng.), A.R.C.S., Assoc. M.I.Mech.E.

Applications are Invited for the following APPOINTMENTS:—
(1) Assistant Master, to teach Applied Mechanics and Machine Drawing. Salary £160, rising by annual increments of £10 to a maximum of £200.
(2) Metal Workshop Instructor. Commencing salary £160.
For Forms of Application, which must be returned not later than August 24th, send stamped and addressed foolscap envelope to R. DEMPSEY, Clerk to the Governors, Town Hall, Leyton. H 482

A Firm of Engineers and Steel Founders can OFFER a good POST to really first-class business man with thorough knowledge of modern systems of works, sales and general office organisation. Preference will be given to one with experience in the engineering or motor trade. Write, stating qualifications and salary required, to BOX 5016, care of A. J. WILSON and Co., Ltd., 154, Clerkenwell Road, London, E.C. 1. H 364

Cost Accountant, Thoroughly experienced, for large controlled engineering works in Clyde area; good salary and prospects for first-class man, only those with good record need apply. Give age and full particulars.—Address, ACCOUNTANT, Wm. Porteous & Co., Advertising Agents, Glasgow. H 473

Clerk, with Experience, to ASSIST in Purchasing Department of Engineering Firm in Midlands, age about 25 years. No man already on Government work will be engaged.—Application, in the first instance, should be made to your nearest EMPLOYMENT EXCHANGE, stating experience and salary required and mentioning this Journal and No. A. 3563. H 455

Engineers with Practical Experience of design of Ferro-Concrete Structures REQUIRED by MOUCHEL & PARTNERS, Ltd., 32, Victoria Street, Westminster, S.W. 1.—Apply by letter, stating age, experience and salary required. H 426

Wanted, Shop Manager, with practical experience on manufacture of Electrical Switchgear. Good possibilities for man with technical education and broad views regarding the handling of labour and efficient use of material. Give references, age and salary expected. No one employed on Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and No. A 3504. H 444

Works Manager Required, to take charge of Government controlled works. Good opening for man of personality with previous successful experience in controlling men and having sound knowledge of modern boiler shop practice. Commencing salary £300. Could take financial interest in Company after proving satisfactory if desired.—Address, H 466, Offices of Engineering

Works Manager.—A really capable MAN, with sound engineering training and experience in works administration, is REQUIRED to take charge of a large aeroplane factory, London, N.W. Applicants need not necessarily have had previous experience in aeronautical engineering. No one engaged on Government work or resident more than 10 miles away need apply.—Write, stating salary required, to H 412, Offices of Engineering.

First-class Experienced ESTIMATOR WANTED by Government controlled works making large and small engines, repetition and general work; man with thorough practical knowledge of machining, fitting and foundries, &c., who could organise and control a department dealing with rate-fixing, progress and demonstration. Only men thoroughly experienced need apply. Permanent position to suitable man. State age, experience and salary required. No one already employed on Government work will be engaged.—Apply your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and H 29.

Storekeeper (Head) Required in a London Electric Generating Station; experienced in modern Engineering Stores, and knowledge of card index system. Works hours, good wages to suitable man.—Write, stating experience and wages required, to A.B., care of J. W. Vickers & Co., Ltd., 5, Nicholas Lane, E.C. 4. H 458

Capable Working Engineer WANTED to take charge of heating apparatus, laundry and other machinery at Hospital. 150 beds, 80 soldiers. State full particulars with recent testimonials and wages required.—Write, before August 20th, to SECRETARY, Warneford Hospital, Leamington. H 475

Wanted, by Electrical Engineering Firm in Midlands on important Government work, a YOUNG MAN of good education for commercial position in Purchasing Department. Previous experience not essential; preference given to one who has received technical engineering education. Young man discharged from army or navy, or unfit for service would suit. No person already employed on Government work will be engaged.—Apply, your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and H 409.

Draughtsman Wanted, thoroughly capable, for large blast furnace and steel works plant. State age, experience, salary required, and when at liberty. No one already employed on Government work will be engaged.—Apply, your nearest EMPLOYMENT EXCHANGE, quoting No. A 3795. G 996

Draughtsman (Mechanical), one used to Jig and Toolwork preferred, WANTED by Midland firm manufacturing ball and roller bearings for aircraft and mechanical transport. Good salary according to experience. No man already on Government work can be engaged.—Application in the first instance should be made to your nearest EMPLOYMENT EXCHANGE, mentioning this Paper and No. A3390. H 217

Draughtsmen Required, used to motor work and internal combustion engines. Permanency for suitable applicants. No person employed on Government work need apply. State experience, age and wages required, to your nearest EMPLOYMENT EXCHANGE, quoting No. A 3476. H 374

Draughtsman (Permanent or otherwise), experienced, for engineers' offices in London. State full particulars. No one already employed on Government work will be engaged.—Apply, nearest EMPLOYMENT EXCHANGE, mentioning this Journal and H 479.

Draughtsmen.—One Leading MAN and One or Two JUNIORS WANTED, in London office. Must have had first-class experience in machine tool or forging machinery work. Permanencies and excellent prospects for thoroughly capable men. No person already employed upon Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning this Paper and H 474.

Draughtsmen.—Wanted, by Electrical Firm near London, TWO DRAUGHTSMEN, preferably with knowledge of electrical distribution boxes, &c. No one engaged on Government work or resident more than 10 miles away will be engaged.—Address, giving references and particulars of salary required, H 464, Offices of Engineering.

Wanted, Draughtsman for the mechanical design of large electrical direct current machines. Nobody engaged on Government work will be accepted.—Write or apply to the nearest Board of Trade EMPLOYMENT EXCHANGE, mentioning this Journal and No. A 3671. G 487

Draughtsman (Junior), for engineers' offices in London. Sufficient if had instruction at Technical Schools. State full particulars. No one already employed on Government work will be engaged.—Apply, nearest EMPLOYMENT EXCHANGE, mentioning this Journal and H 480.

Draughtsman, Junior MECHANICAL, WANTED, by Midland firm manufacturing Ball and Roller Bearings for Aircraft and Mechanical Transport. Good salary according to experience. No man already on Government work can be engaged without consent of present employers.—Application in the first instance should be made to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and No. A 3364. G 843

Wanted, for Controlled Establishment, Experienced Mechanical DRAUGHTSMAN, capable of designing, conveying machinery, steel structures and various metallurgical appliances and supervising construction of same. No one already employed on Government work will be engaged.—Apply, stating age, previous experience, to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and H 415.

Wanted, Draughtsman, over 21 or otherwise exempt, for arrangement and detail work for Engineering Works in Liverpool district. War work. No one already employed on Government work will be engaged.—Apply, stating age, salary and experience, to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and H 476.

Wanted, by Engineering Firm under Government control, ASSISTANT DRAUGHTSMAN, having general engineering experience. Knowledge of jig-making a recommendation. No one already employed on Government work will be engaged.—Address, stating age, salary, experience and when at liberty, H 463, Offices of Engineering.

Wanted, Good Practical Man, to take charge of small works manufacturing insulating material. Must not be eligible for military service.—Address, H 486, Offices of Engineering.

Wanted, Foundry Manager for large Engineering Works in Midlands, thoroughly experienced green, dry sand and loam. State age, experience and salary required. No one on Government work will be engaged.—Apply your nearest EMPLOYMENT EXCHANGE, quoting No. A 3500. H 433

Wanted, Immediately, Experienced MAN, having thorough knowledge of large engineers' works department, for purchasing plates, angles and sectional material generally. Required to prepare indents and place inquiries and orders with largest and best manufacturers and merchants. Good salary to first-class man.—Address, stating age, experienced and salary required, H 442, Offices of Engineering.

Wanted, Foreman over 50 Machines and Lathes, large and medium; capable of getting maximum output. State age, present and previous employers, and wages. No man on Government work will be engaged.—Apply, your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and G 666

A Large Firm of Engineers, in the Midlands, have an OPENING for a YOUTH of good education as premium pupil, the course to include both works and drawing office.—Address, 4359, Offices of Engineering

SITUATIONS WANTED.

Works Manager, 16 Years' experience internal combustion engines, used to modern method of production and controlling large staffs, good recommendations; disengaged now.—Address, H 457, Offices of Engineering.

Engineer (33), M.I.Mech.E., M.Inst.P.T., SEEKS POST General or Works Manager, or Assistant to either in large works, preferably aeroplane factory. Sound engineering training, experienced in works administration and general management.—H 477, Offices of Engineering

Private Secretary and Commercial Assistant to General Manager of engineering firm, SEEKS better POSITION. Fully qualified. Ten years' experience.—Address, H 454, Offices of Engineering.

Discharged Soldier Desires POST. Good knowledge of French, Italian, Dutch and German; also fair Russian and Spanish. Well up in building construction, office routine, &c. Willing to travel. Age 33.—Address, H 403, Offices of Engineering.

Advertiser (25), C iii, and required to do work of national importance, DESIRES ENGAGEMENT. Engineering student at Birmingham University for two years, public school education.—H 454, Offices of Engineering.

Aeroplane Production Engineer, now holding responsible post, DESIRES POSITION as Works or Assistant Manager. Wide experience in Aero and Seaplane and repetition work. Capable organiser.—Address, H 467, Offices of Engineering.

Production Engineer and Progress Supervisor, DISENGAGED, for London district. Aeroplane engine parts and small repetition work. Highest credentials. Ineligible.—Address, H 438, Offices of Engineering.

Young Engineer Requires POSITION as Assistant Manager. Good draughtsman, four years D.O., eight years shop, sound knowledge of filling and manufacture of fuses, grenades, bombs, &c., good experience on jigs and tools.—Address, H 468, Offices of Engineering.

THE VAMMA POWER STATION, NORWAY.

We are indebted to Mr. B. Thoms, the director of the Vamma Fosse Kompagni, for the following interesting account of the large Vamma power station on the Glommen River, Norway. The plant installed at this station is now being further increased so as to raise the maximum output from the present value of 36,000 h.p. up to 60,000 h.p., a figure which is capable of still further expansion. The Glommen River, from which the station derives its water supply, is the natural source of electric energy for the south-eastern districts of Norway, having a larger flow than any other Norwegian river. It has a length of about 310 miles and its catchment area amounts to 16,100 sq. miles, or one-eighth of the total area of Norway. Rising in the Dovre Mountains, the Glommen falls rapidly in its lower reaches between Öieren and Frederiksstad. There are few lakes or other natural regulators on the lower course of the river and none on the upper, so that the discharge varies greatly at different times of the year. At Aarnäs the Glommen receives the Gudbrandsdalslaagen, coming from the high mountain of Jotunheimen, and passing through the lake Mjösen, the largest lake in Norway, covering an area of 140 sq. miles. The Mjösen Lake forms a natural reservoir of great capacity, and it serves as such for some comparatively recent power installations, being capable of holding 800,000,000 cub. m. of water, which can be drawn on during the months of low discharge—December to March. The existence of this lake on its tributary makes it possible to secure a certain minimum flow in the lower Glommen during these winter months. This minimum amounts to 200 cub. m. per second, whereas the natural volume of water in this part of the river, prior to the regulation of the Mjösen Lake, fell in certain dry seasons to as little as 90 cub. m. per second. On the other hand, the maximum discharge during floods rose at times to as much as 4,000 cub. m. per second, and the river is consequently somewhat difficult to exploit.

The most important falls on the Glommen are below Öiren, where it forms the falls of Mörkfoss, Solbergfoss, Fossumfoss, the Kykkelsrud Falls, the Vamma Falls and the Sarpsfoss. The districts on the east side of the Christiania firth, from Frederiksstad to Christiania, have thus plenty of water power within a comparatively short distance, and when, in the nineties, electric power transmission began to gain ground, the Glommen Falls were some of the first to be exploited in the service of industry. The Hafslund concern was formed for the exploitation of the Sarpsfoss, and by degrees several industrial concerns sprang up, a carbide factory, the Norwegian Electric Metal Industry, started by Dr. Gustaf de Laval for the electric extraction of zinc, &c., and by degrees the Hafslund power station was enlarged so as to have a capacity of 25,000 h.p. The Schuckert Electric Company was at one time much interested in the Hafslund concern, but this, we understand, is no longer the case. The demand for electric energy increased, and the Kykkelsrud Falls were next exploited. Actual operation here was commenced on March 15, 1907, supplying three-phase current at 50,000 volts, the highest voltage so far in operation in Europe. By degrees it became necessary to increase the capacity of the Kykkelsrud power station, which now possesses plant capable of exploiting 240 cub. m. of water per second and developing 46,000 h.p.

In the year 1912 it became evident that the energy available at Hafslund and Kykkelsrud would no longer suffice, and the Hafslund concern therefore secured the control of the Vamma Fosse Kompagni. This latter company commenced operations in 1907, but up to 1912 little or nothing had been done towards developing the 60,000 h.p. available at the site. Consequent to the transfer of the concession just mentioned, the Vamma power station has become the third hydro-electric station which supplies energy to the district round Frederiksstad, Christiania, Lillestrøm and Slemmestad. The Vamma power station in its first phase commenced operations in 1915. This third station brings the aggregate capital invested in the power stations and distribution systems to a total of 2,380,000*l.*

The Vamma power station is located at the Vamma Fall, on the Glommen, about 6½ km. below Kykkelsrud and about 32 km. above the Sarpsfoss. The fall, with a regulated volume of water of 220 cub. m. per second, has a head of 27 m., being the aggregate due to the following falls and rapids: the Vammafoss, the Skabbefoss, the Upper and Lower Helifoss, the Vrangfoss, the Alvimfoss and the Erteris Rapids. None of these falls has previously been exploited for any purpose, with the exception of a mill on the left side of the Vamma Fall in bygone days.

The arrangements in connection with the Vamma power station are as follow:—Across the Glommen, at the top of the Vamma Fall, a concrete dam has been constructed, 280 m. long, the central portion of which, over a length of 160 m., has 15 intake openings leading to the sluice valves fitted to the upper ends of the turbine supply pipes. These valves can be laid dry when access is desired to the sluices by means of large drains provided to this end.

As shown in Figs. 1 and 2, Plate XV, the power station is situated at the down-stream toe of the dam, to which it is parallel throughout its length. It has been designed to accommodate 15 main generating units. The transformer house is situated to the north of the station, with which it makes a right angle (see Fig. 1). The by-pass for surplus water is situated to the south of the power station, and consists of a weir with a total length of about 100 metres, part of which, as indicated in Fig. 1, is occupied by two roller weirs, respectively 20 m. and 28 m. long, which are used to regulate the top water-level in the reservoir. An additional fixed overflow weir with its crest at a somewhat higher level is also provided, and with the whole of its components in action the by-pass is capable at need of passing 4,000 cub. m. per second. Photographic views of these regulating weirs are reproduced in Figs. 8 and 9, on page 138, and another view showing the reservoir at about top level is given in Fig. 10, page 150.

The dam, along its entire length, from the northern shore to where it adjoins the flood-water outlet, has its crest at a level of 59 m. above that of the sea. Its greatest height is 38 m. and its greatest breadth at the bottom is 27 m. The breadth at the crown varies from 4.40 m. to 7.60 m. for the different profiles. It rests everywhere on solid rock. The dam is wholly of concrete, which in the most exposed parts is a 1 : 3 : 5 mixture. Elsewhere the mixture is 1 : 4 : 6. The water face is rendered with a layer of 1 to 2 cement mortar, painted subsequently with waterproofing washes. The down-stream slope is faced with granite. The dam has been most carefully drained throughout.

The 15 intakes to the turbines are spaced at 10 m. centres, and there is in addition a smaller intake at the north end of the station which supplies the turbine driving an auxiliary set and the independent excitation plant. Each supply pipe is fitted at its upper end with a sluice valve, 4.5 m. in diameter. These valves are shown in position in Fig. 2, Plate XV, and to a larger scale in Figs. 5 and 6. In front of these there are screens (see Fig. 7, annexed) fitted with electric heating appliances to prevent the adherence of ice, based upon experiments made at Kykkelsrud. From the intakes in the dam the supply pipes, 4.2 m. in diameter, are carried in an S curve along the down-stream side of the dam to the power station. They are embedded in solid concrete at upper and lower ends, and are supported intermediately on two saddles. Suitable provision is made for expansions and contractions arising from temperature changes. The drainage outlets for laying dry the intake sluices are carried down to contour 28 m. on the western side, and consist of openings, 2.7 m. wide and 8 m. high, which on the up-stream side can be closed by two gates, the one above the other. These are manœuvred by winches, placed on a bridge across the crest of the dam.

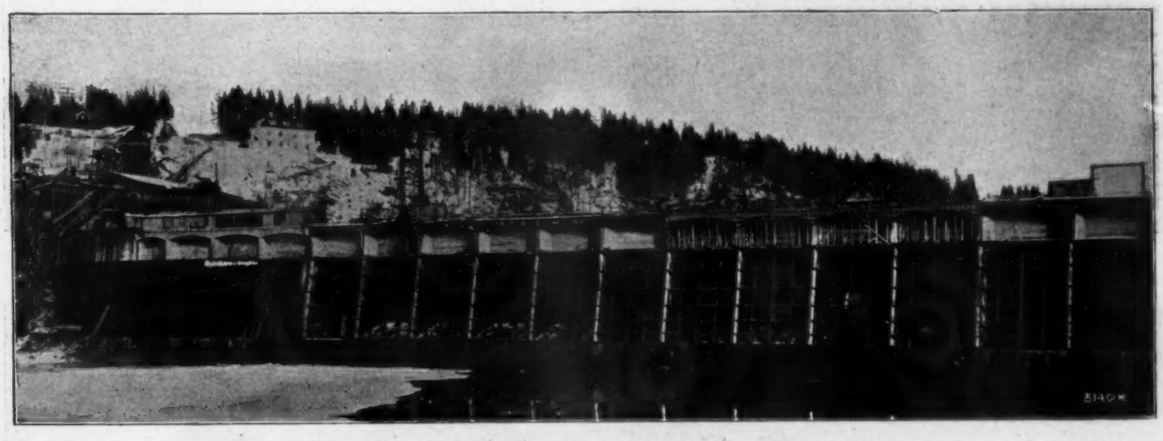


FIG. 7. SCREENS IN FRONT OF TURBINE INTAKES.

The power station is at present built for six turbines of 12,000 h.p. each and two excitation turbines; three turbines of 12,000 h.p. and one auxiliary turbine of 500 h.p. are in use, and two additional 12,000-h.p. turbines are being installed. In future developments the power station can be carried further along the dam. The building for instruments, transformers, &c., makes a right angle with the axis of the power station. Both are clearly shown in Fig. 11, page 150, which represents the station in its first stage of development. In the central portion between the two buildings are workshops, store-rooms and offices. There will be no difficulty in extending them longitudinally when the necessity arises. The buildings are built entirely of concrete, with ferro-concrete roofs.

As the water-level outside the power station

varies from contour 25.5 m. in the winter to contour 33.3 at the highest flood-level, it has been necessary, in order to avoid too great a length of draught tube at lowest water-level, to place the machinery so low that the floor of the machinery hall lies at 2.3 m. and the basement floor of the power station 6.3 m. below highest water-level. The lower portion of the power station therefore had to be built with a special view to its being watertight. This section was accordingly built of a very rich concrete, which required no rendering to make it practically impervious, and care has been taken that the lower portion has been well drained. The results have even surpassed expectation, the structure having proved almost absolutely watertight. The drain water from the lower part of the power station and from the main dam, as far as the portion lying behind the power station is concerned, is collected in two sumps, to which also the water from the packing-boxes of the turbines, &c., is led, and the experience during two summers has shown that it is only necessary to work the drainage pump intermittently for short periods of time. There are two of these drainage pumps, one of which forms a reserve. They have 10-in. inlets and outlets.

The turbines are constructed as double Francis turbines with horizontal shafts, and they have been supplied by two Norwegian works—the Kvärner Company and the Myren Company. On trial under load the efficiency was found to be from 85 per cent. to 87 per cent. With a head of 26 m. they are intended to develop 12,000 h.p., the speed being 214 revolutions per minute. The only controlling valves provided are those at the top of the intake pipes. These valves are, as indicated in Figs. 5 and 6, Plate XV, operated by oil supplied under a pressure of 15 atmospheres, and are controlled electrically from the machinery hall.

The generators are each rated at 12,000 kv.a. They are direct coupled to the turbines and to an exciter on the opposite side. Provision is also made for independent excitation should the need arise. The generators are entirely cased in, and the rotor is fitted with ventilation fans. The rotor draws the air either direct from the open, or if the weather is damp the outside air is mixed with warm dry air from the machinery hall. Each generator has its own air conduit. The heated air is forced into the basement below the machinery hall (see Fig. 3, Plate XV), and from there it is distributed through different channels, either for the heating of the entire power station and instrument house, or the inspection tunnels of the dam, or it may also be sent up to the crest of the dam for heating the oil-pressure installations of the throttle valves, or alternatively the air may be discharged directly into the open. The station switchboard is placed at the end wall of the machinery hall, at a height of 8 m. above floor-level. All the usual measuring instruments are installed, and in addition there is a current-changing system, so that all the generators of the station can be worked in three groups entirely independent of each other.

All the long-distance controls and all the station motors are operated with three-phase current, which is also used for lighting the station. In this way the use of continuous-current motors, with their accessories, is avoided. The energy is transmitted from the generators by means of bright copper bars laid in a gallery, which (as shown in Fig. 3, Plate XV), extends along one side of the power station and underneath the workshops to the instrument house. The mains from each generator lie on a separate shelf, divided by fireproof partitions from the bars of the other generators.

In the instrument house (of which a cross-section is reproduced in Fig. 4, Plate XV) is a small compartment for the 5,000-volt installation of the generators. On account of the large energy units no oil switches have been installed for the 5,000-volt circuits, the parallel coupling taking place on the 50,000-volt side. The instrument equipment of each generator therefore only comprises the necessary knife-switches and current and voltage transformers, and for each

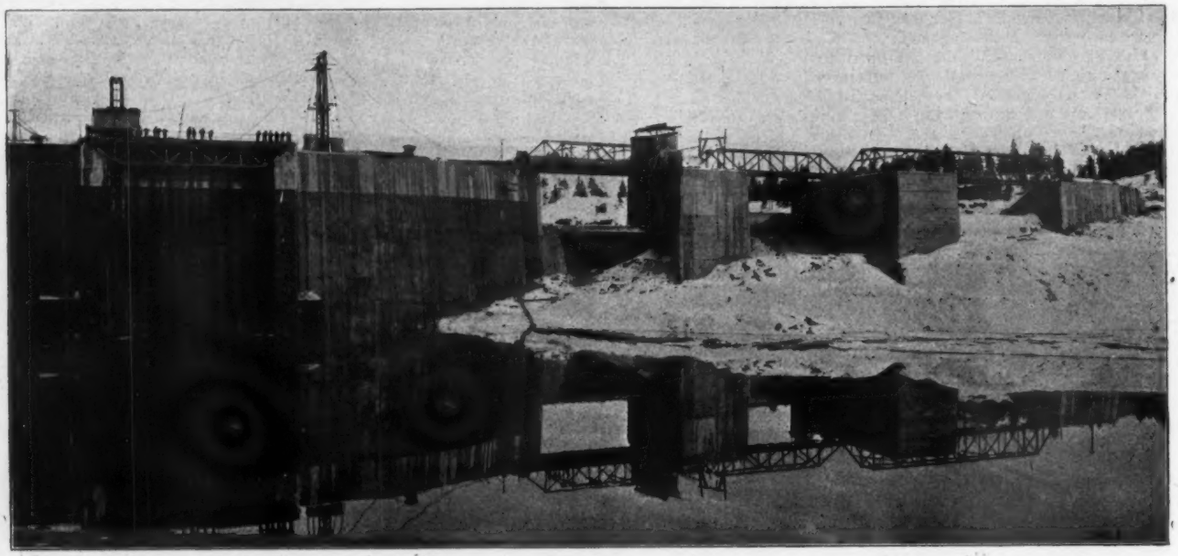


Fig. 8. View of Pool below Dam.

Fig. 9. Roller Regulating Weirs.

generator there is a sur-voltage protection, consisting of horns in star-triangular coupling with oil resistances.

From the 5,000-volt compartment the conductors proceed direct to the transformers, which are placed in an adjoining room. The transformers are each rated at 12,000 kv.a., transforming the three-phase current from 5,000 up to 50,000 volts. They are oil-cooled, the heated oil, by means of pumps, circulating through spiral tubes located in cooling tanks sunk in the floor (see Fig. 4, Plate XV). Two transformers form a group, the cooling installations of which can be coupled together, and the cooling arrangements of a pair form a mutual reserve for each other. On the second floor there are cells for all the oil switches, for the transformers and for the five outgoing 50,000-volt long-distance lines. The oil switches are all arranged for long-distance control and are provided with automatic release gear. In the third story the 50,000-volt bus-bars are located, and these can be divided up in three groups, so that the power supply to Kykkelsrud and on to Christiania can be regulated entirely independently of the supply to Hafslund and Fredericksstad. In the fourth story are installed all the 50,000-volt sur-voltage protection appliances, and these consist of three horns, each with its own oil resistance for each long-distance line, and six horns, star-triangular, coupled with the requisite oil resistances for each transformer 12,000 kv.a.

It should be noticed that in projecting the instrument installations it was decided to make the arrangements as open as possible, and only to install the apparatus actually incurring a risk of fire, the oil-current switches, in fireproof cells.

As insulation "repelite" has been used everywhere, there are no porcelain insulators in the whole establishment. As conductors for the 50,000-volt lines, brass tubes, 30 mm. and 20 mm. diameter, and 1 mm. thick, have been used, and where the strength of the current exceeds 150 amperes copper tubes, 30 mm. diameter, 1 mm. thick, have been adopted. The bus-bars are made of 1¾-in. ordinary iron tubes, with a brass coating, 1 mm. thick. All connections, both between the tubes mutually and between the latter and the apparatus are made with conical screw couplings. The electric plant and instruments have been supplied by a German firm, but the design and the erection of this important undertaking have been carried out by the company's staff of engineers, &c.

THE RAILWAY PROBLEM.

No. II.—BRITISH RAILWAYS DURING THE WAR.

IF we were to be asked to indicate what in our opinion has been the outstanding feature of railway operation during the war, when the railways have been under State control, we should refer to the fact that the "emergency" in connection with which the railways were taken over by the Government has been fully and efficiently met. Whether it would have been as well or better met by the railway companies acting independently of each other need not be discussed. It must be obvious that at a time when the State is by far the largest user of the railways it must be of great advantage to the State to have possession of them. This was recognised as long ago as 1871, when, in the Regulation of the Forces Act (34 and 35 Vic., c. 86) it was provided that "When Her Majesty, by Order in Council, declares that an emergency has arisen in which it is expedient for the public service that Her Majesty's Government shall have control over the railroads in the United Kingdom, or any of them, the Secretary of State may, by warrant under his hand, empower any person or persons named in such warrant to take possession in the name or on behalf of Her Majesty of any railroad in the United Kingdom, and of the plant belonging thereto, or of any part thereof, and may take possession of any plant without taking possession of the railroad itself, and to use the same for Her Majesty's services at such times and in such manner as the Secretary of State may direct." The warrant granted by the Secretary of State must be renewed from week to week so long as, in his opinion, the emergency continues.

Control of the railways is exercised through the Railway Executive Committee of General Managers, of which the President of the Board of Trade is chairman and Sir Herbert Walker acting chairman. The terms of reference of that committee have not been published, nor has it transpired whether there are any limitations to the powers of control which it exercises. But it is known that the Railway Executive Committee was formed before the war, superseding the War Railway Council, and that in August, 1914, what may be termed a statement of policy was issued by Sir Herbert Walker. This notified the public that the control of the railways had been taken over by the Government "for the purpose of ensuring that the railways, locomotives, rolling-stock and staff shall be used as one complete unit in the best interests of the State for the movement of troops, stores and food supplies." As we have already said, in our opinion the railways have efficiently performed their part in the emergency, but we doubt whether even at this date—after three years of control—it could be claimed that "locomotives, rolling-stock and staff" are used as one complete unit. Certainly it was not until twenty-eight months after the railways were taken over that a portion of the goods rolling-stock was brought under a common user arrangement, while covered and special vehicles, passenger rolling-stock, locomotives and staff are still worked under what one may term "company-ownership" conditions. In fact, the statement of policy from which we have quoted proceeded to make the significant reservation that "The staff on each railway will remain under the same control as heretofore, and will receive their instructions through the same channels as in the past." This limitation must have rendered difficult, if not impossible of achievement, the using of the staff as one complete unit.

What must be borne in mind, however, is that throughout the period of control, no less than at the present time, there has been the question of what is to happen after the war. Bearing this in mind, we submit that the Railway Executive Committee has accomplished much in difficult circumstances. To explain our meaning more fully: let us take as an example the common user of open goods and mineral wagons. It is well known that the stock of some of the railways was far superior to that of others. The average carrying capacity was greater, the vehicles had oil axle-boxes, sheet supporters, &c., and generally the standard of maintenance was higher than the average. How could a company so equipped be expected to become a party to a pooling arrangement comprising much inferior rolling-stock? Similar difficulties are met with in any scheme for unifying working arrangements or supervision. All the railway companies have to keep in mind the position of affairs if and when Government control gives place to company control. Thus it is that joint-line organisations are maintained, although not really necessary at the present time; schemes for allocation of traffic to particular routes or railways, for pooling carting establishments for the collecting and delivery of goods, rearrangement and joint user of receiving offices, and similar developments are viewed through competitive spectacles. This aspect of railway operation must be kept constantly in mind in reviewing the working of railways under the present limited Government control as exercised by the Railway Executive Committee.

With this explanation, we propose to set out the principal features of the railway situation since the outbreak of war, and, following the course adopted when considering the pre-war position of affairs, we will do so in sections, viz., railways and (*a*) the State, (*b*) the public, (*c*) the traders, and (*d*) the staff. As regards the State, the primary object of taking over the railways was to ensure that preference should be given to the conveyance of naval and military forces and equipment; civil traffic had necessarily to take a secondary place. But there was another reason. It was anticipated that one of the immediate consequences of a great European war would be a tremendous slump in trade and much unemployment—railway staffs being reduced in consequence. How incorrect this forecast proved to be is now a matter of history, but there is no doubt that it was one of the primary reasons why the Government took over the control of the railways. It was also a feature in deciding the basis on which the railways were to be compensated. That basis was the financial statement for the year 1913. As shown in our review of the railway position before the war, the net receipts for 1913 were higher than they had ever been. The Government, as we have said, thought that trade would fall off. While, therefore, agreeing to pay as compensation for the use of the railways the ascertained deficiency between the net receipts while under control as compared with the net receipts for the corresponding period of the year 1913, it was stipulated that if the aggregate net receipts for the first half of the year 1914 were less than the aggregate net receipts for the first half of the year 1913, the ascertained deficiency should be reduced in like proportion. The effect of this proviso was to reduce the amount of compensation for the period August 4 to December 31, 1914, by about 2½ per cent. Commencing with the year 1915 the proviso was withdrawn in connection with an understanding between the Government and the railways in regard to the first war bonus to the staff—known as the 3*s.* and 2*s.* bonus—the railways agreeing to bear 25 per cent. of the cost of that bonus to employees coming within the conciliation scheme. With this modification the original compensation agreement remains operative. There are, however, certain other payments made by the Government, the principal being interest upon capital expenditure on works brought into use since December 31, 1912, and an allowance in respect of arrears of maintenance of the permanent way, works and rolling-stock. The railways are also secured against financial loss on termination of the control due to depletion of stocks of stores.

The effect of this simple basis of compensating the railways has been twofold. On the one hand it rendered unnecessary any specific payment by the State for work done—men, munitions and stores for the War, Admiralty or Munitions Departments are conveyed in the readiest and most convenient manner without any elaborate system of charging and accounting. On the other hand, the fact that each railway shares in a traffic pool makes it unnecessary accurately to ascertain each company's share of the receipts from traffic passing over two or more lines. Each line is called upon to account for the money it receives—if the net balance exceeds the figure for the corresponding period of the year 1913 the difference has to be paid into the pool. If there is a deficiency, the amount is made up from the pool. This has enabled large economies to be effected in railway *personnel*. The Railway Clearing House staff has been greatly reduced, as also the staff of the various audit and accounting departments. But statistics and accounts have suffered to a corresponding degree. Hence it comes about that the question whether the Government or the railways have had the best of the bargain cannot be answered by reference to any published accounts. It is generally accepted that the railways have performed very much more transport work than they did in the year 1913, thereby becoming entitled to increased receipts. Against this has to be set the cost of materials and enormous increase in the wages bill resulting from war bonus concessions. We are inclined to the opinion that during the first two years of war the terms under which the railways were compensated by the State were greatly in favour of the latter, while the situation has now changed as the result of increased expenditure. The railways also escape any demand for excess profits tax.

Apart from securing prompt and expeditious conveyance of traffic, the Government has been assisted by the railways in a variety of other ways. Large numbers of railway-owned steamers have been taken by the simple expedient of commandeering; rolling-stock and permanent way have been sent overseas; railway workshops have been at the disposal of the State for the manufacture of munitions of war in great varieties; permanent way and other work in connection with munitions and other depots has been undertaken for the Government by the railways. The services of various general managers and other officers have been placed at the disposal of the Government for

special duties (*e.g.*, Sir Eric Geddes, K.C.B., Sir Guy Granet, Sir Sam Fay, Mr. Guy Calthrop, and others); over 150,000 railwaymen have been released for service with the Colours, and generally every effort has been made to assist the Government to the greatest possible extent. The organisation by which this has been done is of interest. First there is the Railway Executive Committee proper, which in the early days of the war met daily and now meets weekly. In association with the Executive Committee there are numerous sub-committees and other representative bodies. Chief of these are the Committee of Accountants; the Committees of (*a*) Goods Managers and (*b*) Superintendents of the Line of the Railway Executive Committee companies, the Mechanical Engineers' Committee and the Conference of Railway Purchasing Agents. In association with various Government Departments there are the War Manufactures Committee; Traffic Control Committee; Recruiting Committee; and committees dealing with questions of timber supply, steamships, matters affecting individual Government Departments, &c. Each of these bodies reports to the Executive Committee, by which means the work of the whole is co-ordinated. It will be gathered that a central feature of the control is the utilisation of the specialist knowledge of the various departments, and the fact that the Railway Executive Committee is wholly composed of experienced railway officers has been a very material factor in the successful working of the organisation, while leaving to each railway a very large measure of self-control. The Railway Executive Committee has also decided the railway policy. When it has been necessary to reduce train mileage in order to liberate locomotives and rolling-stock for overseas the companies have been called upon to act together; to agree the quota of stock which each should supply and the traffic working economies each must effect in the common interest; also the restrictions and new regulations necessary to effect the object in view.

This brings us to the question of the effect of railway working under war conditions upon the public and the traders. That it has been serious it would be useless to deny. The public has had to accommodate itself to a train service which has been repeatedly reduced. True, it is still better than in any of the allied or enemy countries, with, perhaps, the exception of the United States; but it is far below the standard to which the British public had become accustomed, not only as regards frequency, but also speed. To this has to be added the fact that all cheap fare facilities have been withdrawn, while, in order to reduce travel, fares have been increased by no less than 50 per cent. This last change came into force on January 1, 1917, and was sanctioned by an Order by the Board of Trade under the Defence of the Realm Regulations. At the same time the railway companies were authorised to refuse to carry luggage exceeding 100 lb. per passenger. These drastic changes were not made as a means of increasing the revenue of the railways, but—as the Board of Trade announced—solely with the object of curtailing passenger traffic, in order to enable the railway companies to comply with the urgent demands made upon them for the conveyance of troops, munitions and supplies in Great Britain and in France. The increase of fares did not apply to workmen's tickets, season tickets, traders' tickets and zone tickets, and as a further concession to regular travellers it was agreed that where there were alternative routes tickets should be available over either line—a concession which was subsequently modified so far as traders' tickets are concerned. But other equally drastic changes have been made. Dining and restaurant cars were withdrawn from most lines; certain stations and branch lines have been closed to traffic; and collection and delivery services have been curtailed. Traffic dispatched by passenger train has now to be prepaid, and, generally, traders and public have been made aware of what can be effected under State control. This has been especially the case in regard to demurrage on railway rolling-stock. For years the effect of competition between the companies was to render the demurrage regulations practically inoperative. Gradually, however, the railways came together and the charges were enforced, on lines which were based on decisions of the Courts as to what was reasonable. All this took many months to accomplish. The method adopted by the State is much quicker. An Order is made under the Defence of the Realm Regulations, and forthwith the limit of time is reduced and drastic penalties are enacted. The extent of the powers of the Board of Trade will be appreciated from the following:—The department may make orders (*a*) for enabling the Board of Trade to take possession of any private owner's wagons and to use them in such manner as they think best in the interests of the country as a whole, on such conditions as to payment, use and otherwise as may be provided by the Order; (*b*) for enforcing the prompt loading or unloading of wagons, by making failure to load or unload in accordance with the Order an offence; (*c*) for curtailing any statutory requirements as to the running of trains or affording other facilities on certain lines or at certain stations, or for requiring the disuse of any such line or station, in cases where the curtailment or disuse appears to be justified; (*d*) for restricting or prohibiting certain classes of traffic on railways either absolutely or subject to any conditions, and (*e*) for modifying any statutory requirements with respect to the maximum amount of passenger fares.

These powers are certainly extraordinary. Yet the Railway Executive Committee has failed to tackle what is an outstanding feature of wasteful operation. We refer to the system of privately-owned wagons, which are hauled back empty, subject to the very small limitation which will be explained. Before the war, representative railway managers, in evidence before Royal and other Commissions, had cited the British trader's wagon as a source of expense and wasteful operation. Soon after the war broke out the Coal Mining Organisation Committee suggested that colliery wagons should be pooled, and time and again the same matter has been brought under notice. The Railway Executive Committee is understood to have considered the matter, and to have recognised the advantages of pooling by devising a system applicable to railway-owned open goods wagons—yet thousands of traders' wagons are still being hauled empty for thousands of vehicle-miles daily. The only attempt to deal with the matter has been the issue of a Board of Trade Order giving the railways powers to use traders' wagons when returning empty, subject to payment of hire. We doubt, however, whether this Order has effected even a 5 per cent. reduction of such empty haulage. We are not, of course, overlooking the difficulties of solving the problem—but it ought not to be insoluble by railway experts; if it is, the reasons should be made public.

To review broadly the experience of the public and traders we should say they have had to accommodate themselves to materially reduced facilities at—in the case of passenger traffic—increased cost. They have lost most of the refinements of railway facilities and the attentions of the companies, who now are able to bring the State powers of coercion to bear instead of resorting to persuasive measures. As against this it has to be admitted that, after three years of unprecedented war conditions, the railways are providing really excellent services, while goods, mineral and merchandise business of hitherto unknown volume has been handled. Congestion there has been, and will be; traffic has had to be refused or stopped back, and there have been many instances of delays. But no one could contend that the situation to-day is not infinitely better than most people would have prophesied would be the case after so long a period of war, when the demand for metals for munitions is so great that it is difficult to obtain supplies even for upkeep of road and rolling-stock.

It remains for us to consider the position of the railway employees under State control. The men have, in the main, worked extremely well. Strikes have been threatened, but have been conspicuous by their absence. As we have already said, over 150,000 men have joined the Colours, thousands have been killed, and many have secured recognition for meritorious conduct. Release from the railway service is governed by a code of instructions, agreed between the Board of Trade, the Railway Executive Committee and the trade unions of railwaymen. These provide that the railway companies may retain any men whose services are essential to efficient operation of the line. To do this, each man of military age is supplied with a card, which is recognised by the recruiting authorities as exempting the holder from military service. The companies, however, are pledged to release as many men as possible, and this they have done. Indeed, in connection with the recent pressure for more men a demand was made by the War Office for no fewer than 21,000 men to be released from the railway service in the period March to July this year. We understand that the demand has been met, and it is generally understood that very few additional men can now be released. The 21,000 are almost wholly class A men, class B men being released only for service with the railway troops. In selecting men for the army the youngest class A man in each grade and at each station or depot has to go, in the following sequence: first, single men up to age 31, then married men up to age 31; next the single men up to age 41, and finally the remaining married men. As regards married men there is the further proviso that, in respect of each group, the man with the fewest children under fourteen years of age has to go first. To facilitate the release of class A men, men of lower military medical classifications may be used as substitutes. To deal with any complaints by individuals that they have been improperly released, the Board of Trade have appointed a committee—presided over by Mr. Courthope-Munroe, K.C.—to which any man may appeal.

As regards wages, &c., the railways agreed with the trade unions in September, 1914, that the Conciliation Boards as then constituted should continue in being, but that no new agreement revising the service conditions of the men should be made either with the Boards or with deputations during the operation of the "truce." The Conciliation Boards therefore merely meet to discuss local or individual complaints. All the important negotiations have been conducted—first by a committee of general managers and latterly by the Railway Executive Committee direct with the National Union of Railwaymen, the Associated Society of Locomotive Engineers and Firemen, and the Railway Shops Organisation Committee of Craft Unions. The result has been that, by successive increases, the railwaymen generally have been granted a war bonus which now amounts to 15*s.* per week. Most of the craftsmen and associated grades receive 10*s.* war bonus, the remaining 5*s.* having been superseded by an advance of wages of 4*s.* per week. Further demands have recently been presented to the Railway Executive Committee, and it has been agreed that the war bonus shall be regarded as war wages, in the same manner as advances granted to other employees by the Committee on Production.

The primary result of State control of railways in so far as the employees are concerned is that it has solved the vexed question of trade union recognition. Whether or not it has been formally admitted, the unions are now recognised and negotiated with. As a result, trade unionism amongst railway employees has enormously increased. How far this will affect the procedure of the Conciliation Boards remains to be seen, but when the revision of the scheme is taken in hand—it has been in abeyance since the war commenced—there is no doubt that the unions will expect some provision securing to them formal recognition by the railways. This aspect of the matter, however, may well be considered by us in connection with our forecast of the future position of railways.

THE ARRANGEMENT OF MACHINE SHOPS.—No. XVI.

By Joseph Horner.

The service of machine tools includes the selection of suitable storage facilities, both on, or in the tools themselves, and on racks or stands adjacent to them. The choice has to be determined by considerations of greater or less facilities for handling. Tools and appliances which are being constantly used must be always ready to hand.

This is the reason why spanners, and bolts used for clamping, change-gears, milling cutters, arbors, &c., so often have provisions made for storing them in cupboards or on trays, or in racks built into the bases or the frames of machines. And further, why, when these are not available, stands or racks are located adjacent to receive them. An advantage of the rack or stand is, that one of these may serve several machines adjacent to it, when these are arranged in groups according to class, as lathes are, wood-workers and metal turners, and having a rack also for receiving tools vertically. Two features of this are retained in many trays and fittings added to more pretentious machines—the employment of wood and the avoidance of contact between the cutting edges of tools. A good many iron trays are covered with wood, and many provisions made for carrying tools include that of the non-contact of cutting edges. Among the first are the iron trays under some lathe beds, with false bottoms of wood, the wooden shelves, or the pigeon-holes in cabinet legs; among the second are the wooden pegs on which cutters are hung by their holes, and the separating strips, fixed, or adjustable in trays and drawers, to prevent each tool from coming in contact with its fellows, and the holes bored in blocks of wood to receive drills, reamers, and shanked cutters of various kinds in an upright position.

One of the later provisions, too long neglected, is that of employing cupboards in bases and in upright members of machine tools to receive the stocks of tools and appliances which include the necessary equipment of those machines. The adoption of the boxed form of framing and the cabinet legs has afforded the opportunity for the inclusion of shelves and trays, and also of tanks for lubricant. Most machines are now provided with a place or places of storage for the tools and appliances that are in constant use. Racks, and stands adjacent, carry the heavier, less delicate articles, as mandrels, the larger gauges, jigs, fixtures and so on. In the fitting up of cabinet legs and upright framings, shelving is often inserted, and frequently with partitions in order to provide a separate place for every individual article or group of similar articles. A neat method is to make independent wooden frames with shelves and partitions. Another is to have cast-iron trays for miscellaneous appliances—screw-drivers, handles, levers, studs, wrenches, &c. The point is, that a suitable place is provided either for every individual article, or for groups of similar articles.

The examples immediately following are taken from drawings of pans and racks fitted by the Brown and Sharpe Manufacturing Company to their machine tools. Figs. 114 to 116, annexed, show a tool pan provided for the firm's universal milling machines. It is located at a convenient height on the stand, being 16 in. below the centre of the spindle. The two brackets A, A, afford deep abutments to maintain the pan in a horizontal position. Slot holes permit it to be lifted off its supporting studs to empty accumulations of dirt and oil. Flanking the open area a number of slots are cast to receive the shanks of wrenches.

Figs. 117 to 119 illustrate a tool pan for gear-cutter grinding machines. The deep well is for articles of general utility. Six holes in the hinder part receive wooden pegs, over which collars and

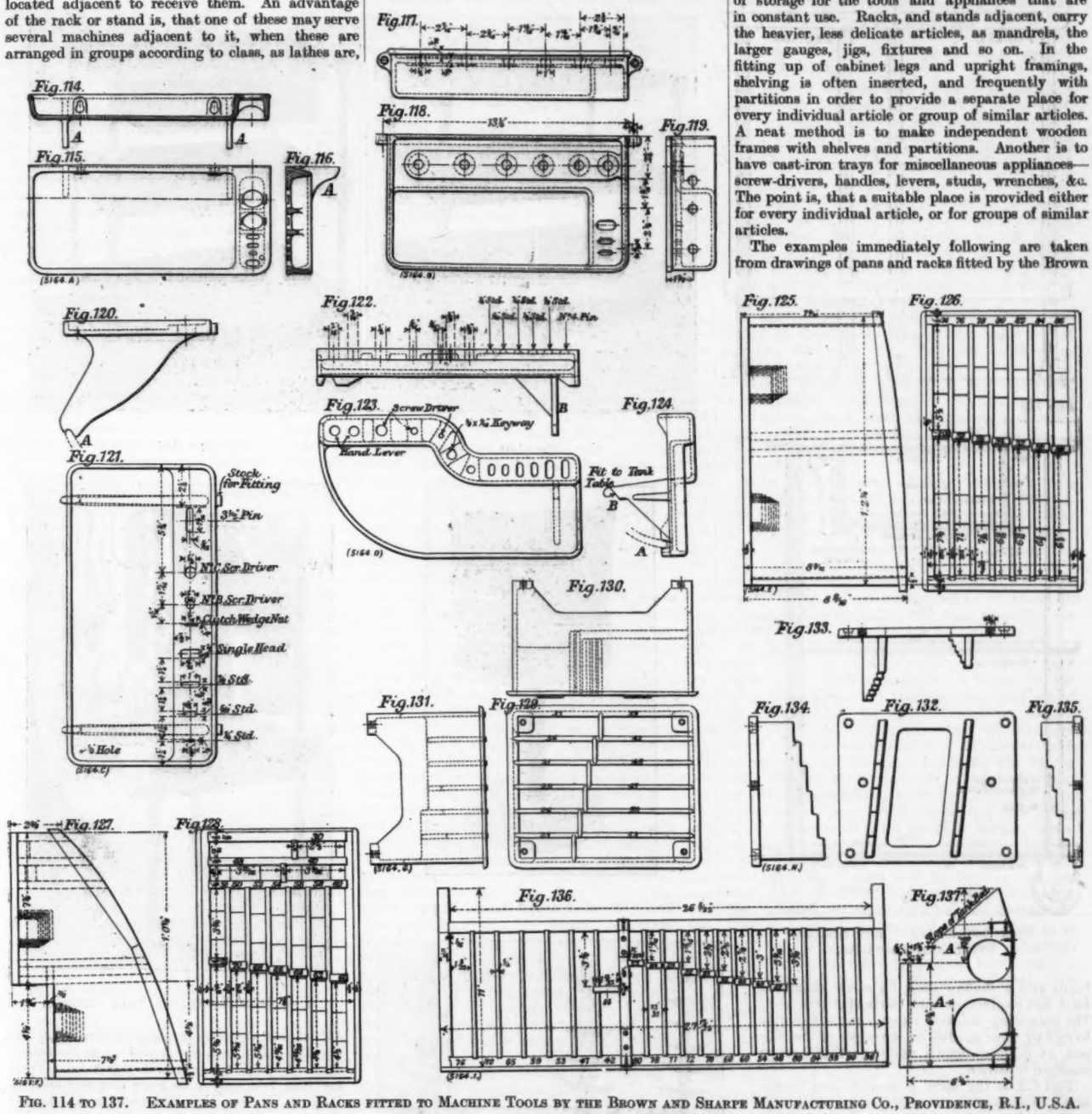


FIG. 114 TO 137. EXAMPLES OF PANS AND RACKS FITTED TO MACHINE TOOLS BY THE BROWN AND SHARPE MANUFACTURING CO., PROVIDENCE, R.I., U.S.A.

or gear-cutters are. Some appliances which are in constant request, as spanners, hold-down bolts, change-gears, gauges, must be kept close at hand, and these are the ones that should be stored on or within the machine. But they ought not to be carried on, or allowed to lie on moving parts, because of the objectionable vibration and consequent setting up of chatter that results on machines where delicate operations are performed, and of risk of inflicting injury on machines or instruments. And when trays are provided they should not be attached to moving parts.

One of the oldest conveniences for the reception of tools in regular service is the wooden tray which is fitted behind the bed in many lathes used by

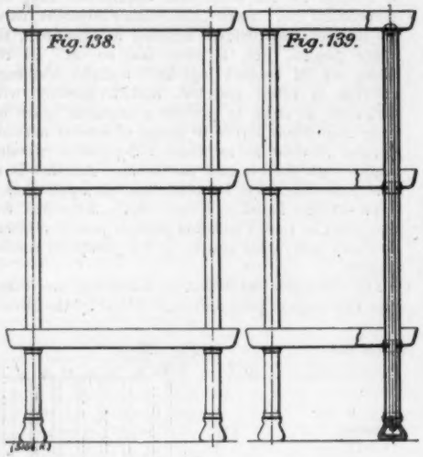
work sleeves are dropped. Three holes at the right-hand side take horizontal studs, over which slotted clamping washers are dropped. Three slots at the same end near the front receive the wrenches.

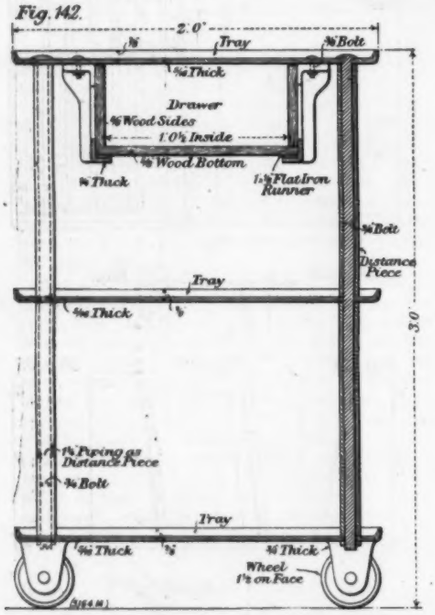
In Figs. 120 and 121 is seen a wrench rack combined with a shallow tray, for screw machines. Each slot receives its own particular tool only. The projecting brackets extend out sufficiently to rest by their notches on the edges of the chip pan at A, upon which the bed of the screw machine is carried.

Figs 122 to 124 show a wrench rack for the firm's automatic screw machines, in which also each tool has its proper location provided. This rack rests on the front rim of the tank-bed at A, and the bracket B fits upon the inside of the tank, and so maintains the rack in a horizontal position. It is easily removed for cleaning out. The tray occupies the extreme left of the bed at the front, where it is out of the way of the work, yet is conveniently situated for the operator.

The parabolic-shaped framing which forms the head of a spur-gear-cutting machine in the familiar Brown and Sharpe design is utilised for the storage of the index-change gears used on the machine, these being kept distinct from the cutter, and the feed-change gears. Figs. 125 to 128 illustrate the loose storage racks which the firm fits to these frames to receive the index gears. It will be seen at once that a recess is provided for each distinct gear and that it can take no other exactly. Also that each one, whatever its size, is brought out to the face of the parabolic curve, to be readily taken out, which exact location is provided for by means of blocking pieces inserted at the rear of the pigeon-holes. The main boxes which receive the partitions are two in number, and they fit within the sides of the frame casting and are separated by the cross-rib which ties the sides of the casting. The views Figs. 125 and 126 are those of the lower box, and Figs. 127 and 128 are those of the upper box, the curve on the face of which corresponds with that of the machine framing at that locality. The blocks which bring all gears to the front within ¼ in. of the curved face are seen in the side views, Figs. 125 and 127. And each one stands out to the correct distance to suit the gear in its pigeon-hole. There are also four spaces for gears disposed horizontally at the top, Fig. 128, making 32 distinct spaces in all, which is the complement of index-change gears for the machines which cut wheels up to 36 in. or to 48 in. diameter. The boxed design, and even the parabolic outline of the upright frame, is thus excellently adapted to be made the place of storage for the gears. The timber-framed skeleton, with boarding united with grooved joints, cannot warp sensibly. And for articles of this kind wood is far preferable to metal.

The gears for effecting the cutter changes and those for the feed changes are kept distinct from the index gears, and from each other in the base of the machine, so that no confusion or loss of time can result from the mixing up of the various sets, which would happen if they were not stored





Figs. 138 to 142. Shop Stands, Fixed and Portable.

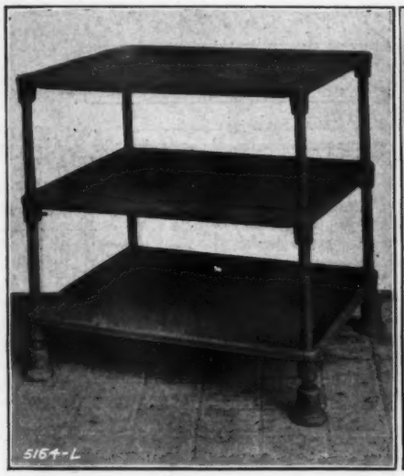


Fig. 140.

Fig. 141.

Fig. 143. Revolving Screw Rack.

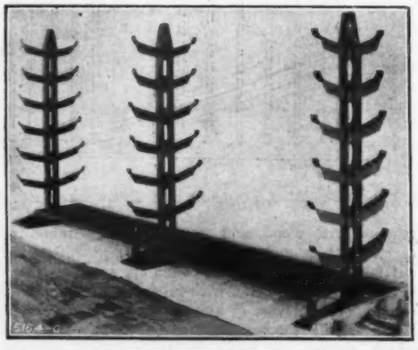


Fig. 144. Stock Rack for Bars and Rods.

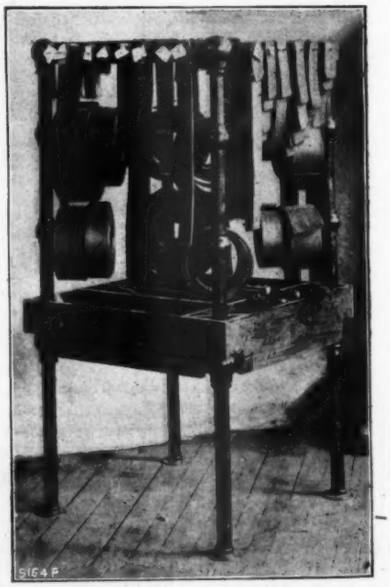


Fig. 145. Stand for Belt Repairs.

separately. One of these boxes—that for the cutter changes—is shown by Figs. 129 to 135. This is of a different character from the previous one illustrated. Its box-like framing is of cast-iron, in one with its partitions, Figs. 129 to 131. The blocking pieces which set the positions of all the wheels within $\frac{1}{8}$ in. of the front are cast with the back plate, Figs. 132 to 135, and the plate is attached to the box with four screws. The setting-out blocks are sloped to cause them to occupy approximately the central locations of the gears. The numbers of the wheels are stamped over each pigeon-hole. Unnecessary weight is removed as shown in Figs. 130, 131 and 132, by cutting out some portions from the plates.

The change-gear box as fitted to some of the Brown and Sharpe automatic screw machines is shown by Figs. 136 and 137. It is made to be fastened up underneath the tank form of bed, which explains the reason of the shape shown in the end view, Fig. 137, the sloping face in which fits the slope of the outside of the bed at the front. The bottom member of the box has to support the load of the wheels, and is therefore tongued into the ends, and is also supported near the centre with angle-iron straps. The partitions for the separate gears are shown in the face view, Fig. 136. Two gears are outlined in Fig. 137, and of course the distances A, A, which extend from the inner faces to the back of the box, are different for each wheel. These dimensions A, are given in the firms' drawings, in which opposite each wheel is stated the length of the block that is required to go behind that gear in order to bring the outer face of the gear within $\frac{1}{8}$ in. of the face of the box. As the box goes underneath the bed it occupies no space that could be utilised in any other way, and the gears are perfectly protected.

The great group of independent stands for receiving tools, appliances and stock has come under the influence of the modern movements towards high specialisation in function and forms. Along with many improvements that have been made on the old, heavy shop-made stands in the direction of lighter scantlings, extended services, more specialised functions, new groups have grown apace, which include provisions for facilitating movements about the shops. These include light portable stands mounted on wheels for the service of the machines when the product is so light that a crane service is not necessary. These stands are in such service preferable to floor trucks, because the stands can be wheeled about anywhere between the machines, many being built exceptionally narrow to enable them to do so. In general outlines the fixed and the portable stands resemble each other. Both are modified to render them adaptable as fixed adjuncts to single machines or groups of machines, or to work-benches, or for peripatetic duties. Some are fitted with plain trays, others have boxes, trays, or pockets; a large group carries stock bars—the rack stands.

Many of the older kinds of fixed stands are heavily made, having ends of cast-iron tied with distance bolts, and carrying three or more shelves between the ends. They may range from about 4 ft. to 6 ft. in length, by from 2 ft. to 2 ft. 6 in. in width, and, say, 5 ft. in height to the top shelf. They are stood against a wall, or out in the open, as happens to be convenient. The shelves being of wood, the edges of tools do not become damaged. These stands carry mandrels, templets, fixtures, bolts, spanners, packings, V-blocks, and other appliances for the use of the machine tools, or rough castings and forgings, or finished articles.

But the home-made timber shelves on cast-iron ends are not appreciated so much now, for they are being largely superseded by manufactured articles in which light castings or pressed steel or drawn steel tubes enter into the construction, with wood fittings in those portions where protection is desired for the keen edges of tools and the fine faces of delicate instruments.

A useful type of stand of small dimensions made in considerable numbers is that shown by Figs. 138 and 139, on page 142. Its shelves are of pressed steel, with raised edges which prevent articles from tumbling off. The legs are of tube. The height of the shelves is set by rings, soldered. The top tray and the feet are united by long cup-headed bolts, for which the feet serve the purpose of nuts. These stands are used primarily for tools, but also for finished work.

Fig. 140 represents one of the shop stands by the New Britain Machine Company, of New Britain, Connecticut, U.S.A. The trays are of pressed steel, and the posts are of solid-drawn steel tube. Bosses on the trays receive the posts. The bosses of the top tray are threaded to receive screws cut on the posts, but those of the lower trays make a sliding fit, in order that vertical adjustments may be made, the trays being clamped with set screws.

In Fig. 141 the same general construction is adopted, but the stand is portable, and a drawer is included for tools. The castors swivel on ball bearings. Each of these stands is made with two or with three trays, and each in two sizes, 26 in. by 20 in. and 32 in. by 26 in. There is also a truck type of stand, having either one tray or two. It has two large wheels, two smaller castor wheels, and an arched handle or bail by which the truck stand is pushed along.

The immense numbers of stands which are now manufactured for sale are mostly constructed on these general lines, with tubular uprights of steel, and trays of pressed steel, or of cast-iron, with, in many instances, provision for vertical adjustments of the middle shelves. Increasing numbers are built to be wheeled about over the floor, and these also are modified for lighter or for rougher service. The first have small wheels on castors, the second have the hinder wheels fitted thus, but the front ones are larger and on a fixed axle. A variation on the lighter design is suitable for the permanent service of a machine. Mounted on castors it is also provided with a lock-up drawer beneath the top shelf, in which private tools of value can be stored.

The value of the portable stands for some services has rendered them popular. They are used for transport between the tool-room and the machines, and also between adjacent machines. They are of more utility than fixed stands are for tools and appliances that are not in constant service, such as special cutters, unusual tools, gauges, jigs, and fixtures, and also for those which are employed in the service of several machines instead of being special to a single machine, as are change-gears, arbors, lathe tools, many milling cutters, and so on. In a large and increasing number of instances these stands are employed in the transportation of work to and from machines, instead of employing overhead tracks with suspended hoists, or portable floor trucks on rail tracks, or independently on floors. The full significance of this fact is hardly yet realised. The advantage secured often is that the portable stands will carry a large and miscellaneous collection of articles greatly exceeding the number which can be transported by hoists, or by the usual floor trucks. They are often of large dimensions and may thus serve several machines at one trip.

A portable stand by Messrs. Messenger and Company, Limited, of Loughborough, is shown in vertical section by Fig. 142. It includes three trays, united by three long bolts passing through tubular distance-pieces, and carried on three wheels. Two feet, which flank the central wheel, furnish steady support to the stand when at rest. Underneath the top tray a wooden drawer is fitted for the reception of tools that need protection.

The lathe pan, portable on wheels, though a chip pan primarily, is made to combine that function with that of a tool holder by the inclusion of a shelf of sheet metal below the pan. Something like this is a workstand with two trays surrounded with side bars which can be raised and lowered to prevent articles from tumbling off. Many stands and trucks are made narrow enough to go through the restricted passage-ways between machine tools.

The examples just named have been of rectangular outlines. There is another group of stands, not portable, which carries a tier or tiers of trays mounted on a central column, around which the trays can be revolved on ball bearings. The column terminates in a foot of ample diameter to maintain the load steadily when the various trays are turned round to bring their contents to the hands of the workman. The chief utility of this design lies in the assembling departments, and in the tool-rooms or the small parts stores. But in some circumstances it is of value around the machine tools. It may carry small machine parts, jigs, fixtures, screws, bolts, tools, as well as finished parts ready for assembling. Four shelves are usually fitted, with raised edges to prevent articles from falling off. The New Britain Machine Company make these in two sizes, with cast-iron shelves measuring 20 in. by 26 in. and 24 in. by 32 in. The shelves are carried on uprights of bar steel.

As there is no separation of parts in the open tray beyond that which is afforded by the distinct shelves, a stand of another type has been designed—the revolving screw rack, Fig. 143. It comprises an upper portion pivoted on a column base, and having circular shelves superimposed, divided into compartments. The partitions can be rearranged to enclose larger or smaller quantities of any particular group of articles, as bolts, screws, cotters, washers, small fittings. The standard size of rack made, Fig. 143, has four sets of compartments, numbering 48 in all, and capable of accommodating from 5 cwt. to 6 cwt. of stock, included in a diameter of 27 in. and a height of 50 in.

In one central pillar design 32 loose pans are carried in three tiers. Though the stand is not portable, the pans are. They are hooked on cantilever supports, so that any pan can be removed and taken to the tool-room or the stock-room and be replenished. This design is intended for small articles only which must be kept apart, as nuts, bolts, screws, washers, pins, &c. At the top a revolving plate receives wrenches, files, and other odds and ends.

To avoid the littering of lathe beds with tools and appliances a stand is made to fit on the bed, with freedom of movement, to follow the tailstock, and with cross adjustments to suit any width of ways. The trays form two tiers, are of cast-iron 18 in. square, and the upper tray stands 14 in. high, and is fitted with a drawer for micrometers or other delicate tools. A bowl is provided for waste, which is apt to become entangled with tools when they are left in contact.

The stock racks for carrying bars and rods comprise another group of shop stands which have acquired an enhanced interest as feeders to the turret lathes and screw machines, and they are of equal value, too, for the shaft-turning lathes. The enclosed type of stand, where the bars are thrust in and drawn out endwise, is not nearly so convenient as are the open-sided racks, Fig. 144, in which they are moved laterally without overhang, and without encroaching on the floor for longitudinal movements. Consequently stands are now made like the illustration, with uprights carrying cantilever brackets standing up at an angle to prevent bars from rolling off. The stands are either single, to abut against a wall, with brackets on one side only, or they are double, having brackets on opposite sides, to stand out in the open like that illustrated.

All the older stands of this type were made of cast-iron, a material of somewhat uncertain character, and therefore proportions were massively designed. But the risk of an accidental blow causing fracture of a bracket already heavily loaded cannot be quite ignored, and therefore many racks now, like Fig. 144, have brackets of mild steel carried on uprights which are built of cast-iron distance pieces. And, further, since in this construction each distance piece forms a separate unit, the stands can be built lower or higher as required, and bars in a large number of different sizes can be kept separate from each other. The ends of the brackets should be well turned up to prevent risk of the bars tumbling off when piled high. These stands are sometimes aligned with the screw machines for which they carry the stock. Then the tops of the uprights are furnished with guides to carry the bars, which are fed through the hollow spindle, the guides being substituted for the usual stand.

Fig. 145 is a stand used to carry the tools and accessories required for the repairs of belts. Trays receive the tools, and belt lengtheners and joint-pieces are suspended from rods. The arrangement is compact, everything is visible, and any article can be selected instantly. This orderly stand is in use in the shops of the Cincinnati Planer Company, of Oakley, Cincinnati, Ohio, U.S.A.

INDUSTRIAL NOTES.

The Manchester Guardian states that at a meeting of the Bradford Chamber of Commerce on Tuesday, July 31, a letter was read from the Liverpool Chamber calling attention to the fact that the Germans are registering well-known British trade marks in Latin-American Republics. The letter added that the Liverpool Chamber was taking steps to enable British trade-mark owners to register their trade marks in those countries at a reasonable cost. One of the drawbacks to British firms registering their trade marks in those countries had hitherto been the great cost. As a result of the steps taken, British merchants or manufacturers were now able to register their marks at a comparatively trifling fee.

Mr. Sutcliffe Smith said the Germans' object, of course, was to enable them to resume their peaceful penetration after the war. One of the ideas of the extreme Pan-Germans, one of their terms of peace, was the abolition of all trade marks in all countries. It was necessary to put British traders on their guard against this kind of thing.

In the course of his speech on opening the new commercial library in Exchange Buildings, Liverpool, on the 1st inst., Lord Parmoor said he looked upon it as connecting up research on the one side and practical business work on the other, and if Liverpool was to give even a greater example in the future than it had done in the past, it would be effected by persuading the business men that, however well they might be acquainted with business methods and skill, they might do better if they would allow themselves to realise that in the statistical commercial knowledge of the world there was much they would do well to study. He was a great believer in research and study and in collective action, but if they allowed that to supersede what he called the vitalising effect of individual energy, they might purchase the advantage at too high a rate; what he wished to impress upon the gathering was, that however much they might depend upon research and knowledge, there was something in the energy and the life and perseverance of the individual on which he had relied in the past in our English commercial enterprise, and which he hoped would not be less potent and less powerful in the future.

Lord Parmoor added that he wished to make a suggestion as to the direction in which an improvement in commercial education ought to take place. What our forefathers did, and did very effectively, was to support what was called the educational side by a system of apprenticeship, and they realised, and he thought we ought to realise, too, that after a certain age a boy or a young person could not be better trained than to become an expert as far as he could in the particular industry of which he intended to devote his life. He thought they ought to a great extent to revert to the old apprenticeship system in order that boys after a certain age might be taught in a sufficient time all the skill they could learn in the particular industry to which they would be devoted in after life. If that were done he thought the jealousy against what was sometimes called the waste time in education would disappear. What people felt, and he thought rightly felt, was that after a certain time they could not afford more intellectualism, they could not afford more brain training, but they must direct the mind on scientific bases in order to gain skill in some particular industry or branch of commerce. He hoped that that would be the direction of educational reform—an alteration which would give boys information on the very points upon which they ought to be practically trained in order that they might be fitted to become merchant adventurers or merchant manufacturers in the future.

At the general meeting of shareholders of Messrs. Dorman, Long and Co., held in Middlesbrough on July 31, Mr. A. J. Dorman gave particulars of the new steel works the company were building at Redcar. These will contain a 400-ton mixer, 10 large steel furnaces, a cogging mill, and two large plate mills; the new plant is to cost about 2,000,000*l.*, and is expected to produce about 400,000 tons per annum, making the total annual output of the company's concerns about 1,000,000 tons.

Dealing with the future relations between Capital and Labour, Mr. Dorman said that many took a gloomy view of what was likely to happen after the war, but, personally, he was not one of those. He believed, if they were allowed to manage their own affairs, employer and employed in conference together would arrive at a happy conclusion. To his mind the problem to be solved was to settle the price at which the workmen would give their best labour free from all restrictions. It must be evident to all thinking men that no high wages could be paid except in return for efficiency and increased output. Given that, a settlement would be an easy matter, for the employer did not ask for increased hours and harder work—improved machinery would do the hard work. Under such conditions it was possible to pay higher wages and yet produce at lower cost. We could assemble our material at less cost than most nations, and had shipping facilities second to none. Our manufacturers had received little or no encouragement to embark in large commercial undertakings, and our machinery had been allowed to become somewhat antiquated, but a new life was springing up within us, and, if only a fair understanding could be come to between Capital and Labour, he had no doubt that the new industries that had been brought into being would prove to be a source of great prosperity to this country, and enable us to hold our own in the markets of the world. For obvious reasons, there was not likely to be any great alterations in their returns during the continuance of the war, but when peace came it would doubtless bring with it a large demand for shipbuilding and constructional material, for which they would be well prepared.

Speaking at the twenty-ninth annual ordinary general meeting of Messrs. Greenwood and Batley, Limited, at Caxton Hall, Westminster, on Tuesday, July 31, Colonel O. C. Armstrong, D.S.O., chairman of the board, said that in regard to the future they were seriously considering the best probable lines of development which should be followed. There would be, he stated, plenty of work for some time following the declaration of peace, but at a later period the keenest competition would have to be faced. The present basis of taxation of profits precluded the creation of such reserves as would enable industrial concerns to develop and meet that foreign competition which was sure to arise. It was to be regretted that this was not taken into account when these war taxes were imposed. It would have been quite possible for the Government to have treated a percentage of excess profits tax levied on individual firms as a loan, to be repaid at the end of the war, subject to the condition that it would be employed solely in the development and extension of their business. To impose such restrictions and guarantees as would preclude these funds from being diverted to other purposes would not be difficult, especially in view of the organisation already established to deal with the accounts and affairs of the companies concerned. British companies would have to rely very largely on foreign trade to lessen the eventual enormous war debt. Any steps, therefore, which would materially increase the balance in their favour would have been not only justifiable but prudent.

The Minister of Munitions (Mr. Churchill) accompanied by Mr. Kellaway (Parliamentary Secretary to the Minister), and officials of the Ministry of Munitions, the Admiralty, War Office, and Ministry of Labour, met representatives of the shipbuilding and engineering trades at the Central Hall, Westminster, on the 1st inst.

Mr. Churchill explained that he had asked the unions to send delegates to meet him on taking up office so that he might have an opportunity of a frank and informal exchange of views. He stated that he did not propose to announce any definite policy, but wished to weigh with a free mind the views of the delegates and the general labour problem. He emphasised the urgent need of maintaining and increasing the output of munitions. The attainment of this object depended to a large extent on labour and an increased supply of labour. He referred to certain causes of industrial unrest, notably the effect of fatigue, the difference between the rates of skilled men on day work and semi-skilled and unskilled men on piece rates and the provision as to leaving certificates. He asked for suggestions from the delegates on these points. A full and general discussion followed, which extended over two sessions, at which a large number of points were urged by the representatives present. The discussions throughout were of a practical and friendly character. Mr. Churchill, at the conclusion of the meeting, thanked the representatives for the helpful way in which they had met him and for the suggestions they had made. He would weigh them carefully. He asked them, however, to remember that he must consider the position not only from their point of view, but from the point of view of the nation as a whole. He replied to some of the points raised, and asked the delegates to return in the near future to enable him to discuss the position with them in the light of his consideration of the whole matter.

The labour conditions in Norway are pronounced to be simply impossible, in a good many directions at least, a fact which is attributable to the highly undesirable influence of the syndicalists, to the failing power of the large labour unions, and to the shortage of labour, which makes the men exceedingly independent. It had been hoped that arbitration in the protracted miners' conflict last year would have secured a temporary quiet, but such has not been the case, the men not abiding by the terms of the award, although in most cases they are exceedingly well paid. Thus the average wage of miners during the first quarter of the present year amounted to 1 krone 11 öre (about 1*s.* 3*d.*) per hour. At present the men have unlawfully stopped work at four or five important mining concerns. At the Foldal concern work is stopped because the men were dissatisfied with an award. At the Sulitjelma copper mines the men demanded the immediate discharge of one of the engineers; this being absolutely refused, the men struck, but were immediately ordered by their union to resume work, which they did, but their journals give the version that the men had allowed the engineer in question to remain on trial in the meantime, and called it a victory for direct action by them. At the Dunderland Iron Ore Company there is a strike, the men demanding an increase of 3 kroner to 4 kroner (about 4*s.*) per shift. At the Orkla Mining Company the Swedish syndicalists have been busy; the men, some little time ago, demanded that a hand who had received 14 days' notice and the offer of work elsewhere should be taken on again, if not, the men would go out at 10 o'clock Sunday night. The central union of the men entered a protest against the strike, but the men took no heed, went out, and still remain out. The employers decline any negotiations till the men come back. At the Merather mines some of the men, without any notice whatever, left off work because the company would not concede an altogether unreasonable demand for increased pay. The men's union has requested the men to resume work immediately, the strike being illegal, but the men take no notice and the strike goes on.

This unsatisfactory state of affairs is due to the growing influence of the local labour organisations, whose programme is very syndicalistic, and who have no respect either for agreements or tariffs. Things were much better when the central unions had the men properly under control. Considerable apprehension is felt as to the effect which this state of the labour market is likely to have on the country's industry generally in the present difficult times.

It may now be taken for granted that the Norwegian coal-mining at Spitzbergen has virtually come to an end for the time being, and the result of the year must be pronounced unsatisfactory. This, and the recent stoppage of work is due to the unreasonableness of the men employed, who declined to listen to the mediator who, at the request of the coal company, proceeded to Spitzbergen. The men blankly refused as inadequate a rise of 10 per cent. to 20 per cent., although the pay was already very high—as much as 20 kroner (about 23*s.*) per day, free lodging, and practically free board. The whole staff of men will probably now be discharged and brought back to Norway. Owing to the advanced season it will hardly be possible to engage a fresh set of men and have them conveyed to Spitzbergen in time for this year's shipments, which close in September. The stocks already worked for shipment are insignificant, as the greater part of the winter and spring has been devoted to preparatory work with a view to rational mining during the summer. At Spitzbergen, as at several places in Norway, the trouble, it is alleged, comes from Swedish syndicalists, who incite the men to rebellion and demoralise them.

The following abstract from the report of the Commission on Industrial Unrest completes the note we gave on page 116 *ante*:—*Wales*: Commissioners, Mr. Lleufer Thomas, Mr. Thomas Evans, Mr. Vernon Hartshorn and Mr. Edgar Chappell. In spite of the bitter hostility frequently displayed between the employers and men, the cleavage is not so great as to prevent more amicable relations being established, and the Commissioners express the hope that in view of the serious industrial situation which must be faced after the war, both sides will make every effort to come together in a less antagonistic and more reasonable spirit for considering the economic and other problems relating to industry. The conviction that capital and labour are hostile has been accentuated by the unsatisfactory social conditions of the working classes. There are complaints as to profiteering; there is also to be found lack of confidence in Government pledges, whilst other factors making for unrest are inequality in wages, nervous strain due to overwork, and restrictions on individual liberty enforced by various Government Acts. Nevertheless the Commissioners have full confidence in the loyalty and patriotism of the workmen, and they believe that by adjusting the wages to meet the increasing cost of living, or by reducing the prices of foodstuffs, all industrial trouble can be averted whilst the nation is at grips with the enemy.

A labour conflict is at present going on in Denmark, where the shipyard labourers, and not the skilled

workmen, have been out on strike for some time. The matter was brought before the permanent arbitration court, which decided against the men, their union being fined 2,000 kroner (about 115*l.*). The men refused to comply with this award and continued the strike, with the result that the matter was again brought before the permanent arbitration court, the decision naturally going against the men, their union being fined 30,000 kroner (about 1,700*l.*), the highest fine ever imposed by the court. The union not having adequate funds, it has been declared bankrupt, at the instance of the employers' union.

The Minister of Munitions, in exercise of the powers conferred upon him, has ordered the following:—(1) No person shall buy, sell, deal in or dispose of any blast-furnace dust except under and in accordance with the terms of a licence issued on behalf of the Minister of Munitions by the Controller of Potash Production. (2) No person shall treat any such dust so as to extract any component part thereof except under and in accordance with the terms of a licence issued as aforesaid. (3) All persons producing or in possession of blast-furnace dust shall make returns in regard to rate of production, stocks, purchases, sales, dealings or other matters relating to blast-furnace dust in such form and at such times as may be required by the said Controller. (4) Samples of any blast-furnace dust produced by or in the possession of any person shall be furnished to the said Controller by such person in such form and quantity and at such times as the said Controller may prescribe. Such samples shall be taken in such manner as the said Controller or his authorised representative may prescribe. (5) For the purpose of this Order blast-furnace dust shall mean dust deposited or otherwise derived from the gases of any furnace used for treating ores for the production of iron or any of its alloys. (6) All applications in reference to the above Order should be made to the Controller of Potash Production, Ministry of Munitions, 117, Piccadilly, W. 1.

The Ministry of Munitions announces that it has applied to controlled establishments in Ireland the Orders regulating the wages of women and girls employed on munitions work which have been applied to establishments in similar trades in Great Britain. The Ministry is considering the case of uncontrolled establishments employing women and girls on munitions work with a view to seeing whether its powers in respect of the wages of such women and girls can be exercised in those establishments also.

Following the decision reached by the management of the Pennsylvania Railroad last spring, more than two thousand women and girls have entered the service of the lines east of Pittsburgh and Erie, in the operating department alone. The total number of girls and women at present working in the operating department is 2,360, and the most of these have been engaged during the last two months. Among the forms of railroad service now being performed by women are the following:—Seventy-one signalwomen are at work, and six student signalwomen are on the pay-rolls; there are four women locomotive dispatchers, 19 station cleaners, 206 car cleaners, two draughtswomen, 104 messengers, 20 student messengers, 10 extra messengers, 23 station agents, one ticket seller, three bureau of information attendants, one pump attendant, 42 block operators, two machine hands, five street watchwomen, five upholsterers, one parcel-room attendant, 12 drawbridge tenders and 18 store attendants. In the lines of work more customarily followed by women there are 433 telephone and private branch exchange operators, 84 matrons, 29 janitresses, two stewardesses, 78 stenographers, 1,102 clerks, and one cook.

The announcement that the Pennsylvania Railroad proposed to employ women on a large scale was made on May 1, 1917. At that time practically the only women in the service, on the lines east of Pittsburgh, were a few station agents, telegraph and telephone operators, &c., and a limited number of women clerks who had been experimentally employed in one of the large departments in Broad-street station, Philadelphia.

In view of the fact that the younger men of the country will shortly be called into military service, the management of the Pennsylvania railroad has decided to suspend, temporarily, the regulation covering the age limit for employment. The rule heretofore in force prohibited the hiring of new employees, in any branch of the service, above the age of 45 years. Under the new rule, which has been adopted to meet war conditions, persons between the ages of 45 and 70 years may be employed during the war and for a period of six months thereafter. Inasmuch as such employment is not to be considered permanent, it will not carry with it the privileges of the pension department. This new arrangement, it is believed, will offer an opportunity for large numbers of those who are beyond military age to perform a patriotic service to the country, in the war emergency, by assisting in the indispensable work of maintaining railroad operation.

WANTED: A NATIONAL ASSOCIATION OF ENGINEERING FOREMEN.

TO THE EDITOR OF ENGINEERING.

SIR,—I have received quite a number of letters from readers interested in the above proposal. The initial difficulties are great, but the best method of inaugurating a national scheme would be for each centre to form a local association and when a sufficient amount of support is received to affiliate with a headquarters' council formed out of representatives from each association. The main objects of the associations should be (1) the raising of the status of engineering shop managers and foremen, (2) the education and mutual improvement of members, (3) the interchange of opinions and ideas connected with the progress of the mechanical trades, and (4) the provision of funds for benevolent objects.

At the moment the most important thing to be done is to make urgent representations to the Government as to the present conditions of changing one's position. Foremen and managers were pitchforked into the scope of the Munitions Amendment Act of 1916 without their consideration; this, I think, was entirely unfair, and has reacted against the national interest. The men, by means of their unions, were able to barter for the numerous increases in pay they have received since the passing of this Act. Foremen and managers have been obliged to remain where they were and to be thankful for any crumbs that might fall from the table. I must, however, record that many employees have awarded output bonuses to their foremen: which is quite a fair and equitable arrangement.

I await with interest for further evidence of the need for a national association.

Yours faithfully,

"THE WRITER OF THE FIRST LETTER."

CORROSION OF CONDENSER TUBES.

TO THE EDITOR OF ENGINEERING.

SIR,—Your correspondent "C. de F. M.," in his letter to your columns of August 3, appears to accuse me of what is known as "The scientific use of the imagination," an expression of which we have heard a good deal of late and which, reduced to its lowest denominator, merely means the application of commonsense to scientific investigations. As I find this process is of universal application I have very little to reproach myself with.

His letter is a difficult one to deal with. It contains so many errors in premise and theory that it would take up too much of your space and too much of your readers' patience and my time to deal thoroughly with it. I will, however, endeavour to show the utter fallacy of his theory as briefly as space and time will permit.

That small fragments of coke were found in the perforations in his tubes merely implies that the holes were small enough to trap them; shrimps, small fish, wood and various substances are found under similar circumstances. If coke was not found in the upper tubes it only shows that, being light, it had been washed clean through, and had there been no perforations in the lower tubes the same thing would have happened there. After re-tubing the lower half of his condenser no provision appears to have been made to prevent the same thing happening again, and presumably coke and cinders still passed through without roughening the tubes, trapping air or causing corrosion.

"C. de F. M." then proceeds to develop his "mechanico-chemical" theory in spite of the fact that his experiment (a single negative one) proves that coke does not roughen the brass and, even if it did trap air, did not influence the rate of corrosion.

"C. de F. M.'s" conception of the oxidation of metals by air is very primitive. Metals do not oxidise by mere contact with air or oxygen, and the purer they are the better they resist oxidation. I have a sample of tin so pure that it takes weeks instead of minutes to dissolve in hydrochloric acid, and a pure sample of zinc does not appear to care whether it gives off hydrogen or not when it is placed in the same solvent. If, however, they are placed in contact with a piece of platinum they dissolve rapidly. It is not too much to say that if it were possible to obtain absolutely pure metals free from crystalline and other strain they would be insoluble in the ordinary solvents. In the question before us it is impossible to dissociate oxidation from electrolysis. It is the air in solution which effects the oxidation and not the free air. The metal actually in contact with a bubble of air is protected from corrosion, while the water in the immediate vicinity, being kept saturated with oxygen, causes a ring of corrosion around it. The chances of air or coke particles clinging to a condenser tube under normal circumstances is very remote, but where it is functioning as an auxiliary condenser such a condition of affairs is not unlikely, and in such cases of air deposition we get the ring or horseshoe type of corrosion at the inlet ends. The corrosion experiments quoted by "C. de F. M.," so far from proving his mechanico-chemical theory, only serve to strengthen the now generally accepted theory that air dissolved in water —especially sea water—is a very effective electrolyte.

Another error that "C. de F. M." falls into is that mechanically-detached copper, if precipitated on some portion of the tube, would simulate the appearance of an electro-deposit; if he had any experience in electro-metallurgy he would understand that such a thing was impossible. With regard to the analysis quoted in his letter: I must admit the figures knock all the conceit out of me as an analyst. I had always had a suspicion that a determination carried to the second place of decimals was a doubtful refinement, but a chemist who can extend them to the fourth place and provide a cipher in the fifth, while leaving nearly 0.2 per cent. unaccounted for does not, to say the least, inspire one with confidence. The idea of expressing corrosion loss as a percentage instead of per unit area is also somewhat novel and, if I may be allowed to suggest it, somewhat unscientific. My own attempts at quantitative corrosion experiments gave results so erratic that I refrain from publishing them. It would have been quite possible to pick out a set of figures to suit my theory, and I am always a little doubtful of many of the published figures unless they bear the hallmark of a careful experimentalist.

In the last paragraph of his letter "C. de F. M." quite unconsciously hits on a solution which will go a long way to curing the trouble. It is the same solution that I and others advocate.

Had "C. de F. M." marshalled his facts a little better, his flight into the realms of imagination would have spared us that hybrid horror, the mechanico-chemical theory.

Yours faithfully,

WILLIAM RAMSAY.

23, Sycamore-road, Higher Tranmere, Birkenhead, August 8, 1917.

THE RELATION BETWEEN ATOMIC NUMBERS AND ATOMIC WEIGHTS.

TO THE EDITOR OF ENGINEERING.

SIR,—Now that Prout's hypothesis has been definitely re-established and that according to Sir J. J. Thomson's latest views the units building up the positive nucleus of an atom are identical with the units of atomic weight, while the atomic number is now supposed to represent the relatively lesser number of electrons within an atom, may I be allowed to suggest a mechanical equivalent for these atomic numbers? According to my own heretical views, already by your courtesy partly expressed in previous letters (particularly page 18, vol. cii, January 5, 1917), the ether is material and atomic, and a unit tube of electrostatic force represents the effort of a complex inequality to revert, as mathematically but not mechanically demonstrated by the late Professor Osborne Reynolds, so that the electron represents the absence of an ether atom. The "detachable" electron representing atomic combining capacity is simply the hole in the interpenetrating ether formed by the escape of an ether atom or of a monad metallic chemical atom, as the case may be. The further view, which you will kindly now allow me to publish, is that a neutral atom swims in the ether, but that as its weight is increased in accordance with the periodic table so the cubic space occupied by its positive nucleus increases also and displaces entirely a number of ether atoms corresponding to the atomic number. The shapes of the typically-perfect acidic atoms, namely, carbon, nitrogen and oxygen, which I published in 1900,* support this view and to my mind are as demonstrable as a proposition of Euclid.

It then follows that the quantum of energy is no longer to be looked for inside the atom, but resides in a unit action of a material ether, so that the product of the energy and the wave-length always equals the constant *h* (see diagram, page 516, vol. cii).

Yours faithfully,

FRED. G. EDWARDS.

33, St. Ronan's-road, Sheffield, July 30, 1917.

JAPANESE SHIPBUILDING AND SHIPPING.—In view of the very prosperous condition of the shipbuilding industry, the Japanese Government, says *The London and China Telegraph*, is reported to have decided to discontinue the grants of shipbuilding subsidies after the next fiscal year, and a proposal to this effect will be introduced in the forthcoming special session of the Diet. The prosperity in the Japanese shipping trade, adds the same journal, continues at high-water mark. Owners are rapidly disposing of their ships at phenomenal prices, on the principle, we suppose, of making hay whilst the sun shines. One steamship company recently sold all its vessels and other property, and deducting from the proceeds of the sale all the liabilities, was able to pay the shareholders 1,000 yen for each 5 yen paid-up share. A similar course has been taken by other companies. It is stated that one of Kobé's new shipping millionaires recently sold off the few ships in his possession and realised nearly 10,000,000 yen, though he paid less than half that amount when he bought them. There is, however, another side to the picture, as was lately pointed out by the Japanese Minister of Communications, who, in a recent speech, urged Japanese shipowners to stop selling their vessels to foreigners. He pointed out that at the conclusion of peace Japan would require every ship she had or could get to be in a position to maintain the great increase of trade the war had brought her, and also further to develop her foreign trade. He expressed the opinion that, for some time after the war, there would be no falling-off in the demand for ships, nor in the profits to be obtained. Japanese should, therefore, "love their ships," so that with a vast mercantile marine the country might be in a position to reap every advantage from the demand for tonnage. Despite this warning, Japanese owners seem still inclined to sell their ships at top prices and invest the capital elsewhere.

* "Chemistry An Exact Mechanical Philosophy." Churchill.

SAND-SETTLING BASIN FOR HYDRAULIC PLANTS.

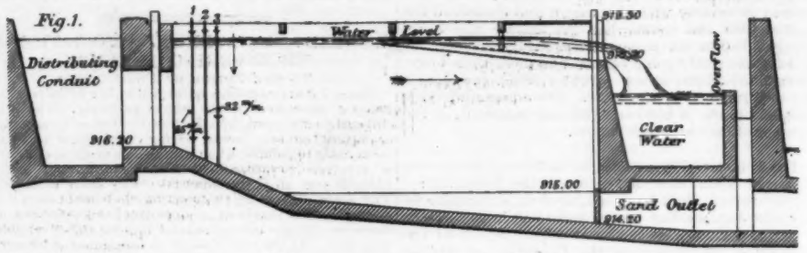
The sand-settling basin which we illustrate in Figs. 1 and 2 on this page was adopted by the Aluminium Industrie A.G., of Neuhausen, a suburb of Schaffhausen, on the Rhine, Switzerland, for their new hydraulic power plant near Sitten (Sion), on the Rhône. Sand had caused trouble in the turbines of the company, and had occupied the particular attention of their general manager, Dr. M. Schindlor; the arrangement illustrated is due to Mr. J. Büchi, of Zürich, who describes it in the *Schweizerische Bauzeitung* of June 23; we are indebted to our contemporary for our diagrams. The waters to be dealt with are those of the Borgne, which comes from the high Alps south of Sitten, and of the Dixence; the two rivulets are now joined near Santerot. Cleared of their gravel the waters enter a longitudinal distributing conduit, from which they pass into the settling basin, which is divided into 10 chambers, each 10.5 m. long and about 2 m. wide; the depth of these chambers increases from 3 m. to 5 m. The clear water overflows at the end of the chambers, and the deposited sand is discharged through sluices at the bottom of the chambers. In the experiments made by Dr. Schindlor and Mr. Büchi before the adoption of the device the rate of flow through a chamber ranged from 800 litres up to 1,060 litres per second, the higher figure being equivalent to about 220 gallons per second. When the water was sent into the empty chamber, devoid of any fixtures, as shown in Fig. 1—the view, Fig. 2, represents part of the longitudinal section of Fig. 1 on a larger scale, with the fixtures—the main current, constricted at the entrance (Fig. 1), kept first near the bottom of the chamber, and then curved up to the overflow. The stream-lines, observed by means of dyes and powdered sealing-wax, were very close to one another, and fine particles of sand were carried away over the overflow, only coarse sand particles settling on the bottom. All that was expected, of course, and was in accordance with the determination, by means of Amsler vanes, of the rates of water flow. Various devices were tried to obtain a uniform current of reduced strength; vertical gas pipes proved most efficient, and they were arranged in three rows (Fig. 1), grouped closer in the middle than near the sides of a chamber; they were pipes of 25 mm. and 32 mm. (1 in. or 1¼ in., about).

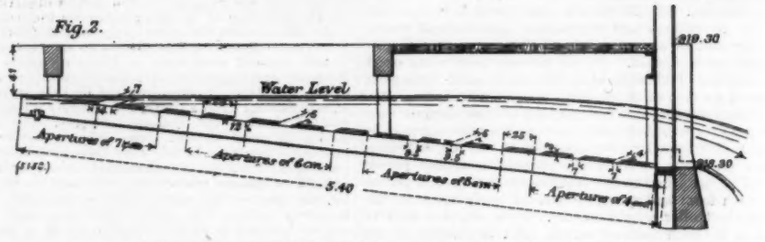
Since it was not feasible to experiment on the quantity and size of the sand grains in the turbid summer water of the rivulets, sand grains were introduced, near the point marked by an arrow (Fig. 1), into the clear winter water through funnels reaching to different depths, and the rate of their settling was determined. It resulted that the upper layers of the water became clear within a few metres from the introduction of the sand.

This observation was utilised to increase the efficiency of the device. If it were possible to withdraw (by suction, *e.g.*) this upper layer of clear water, the water remaining in the almost unchanged cross-section would flow less rapidly, and the sand would settle more quickly in paths more nearly vertical. If the withdrawal of the cleared-water layer were repeated several times as the water approached the end of the basin, the cross-section would be more and more relieved and the paths of the grains of sand would become more and more vertical. To effect this repeated withdrawal baffle boards were introduced in the upper portion of the basin, and they were first, during the experimental stages, not rigidly fixed as in Fig. 2, which represents the actual arrangement, but in louvre fashion. Each baffle could turn about its pivot in a lateral framing, so as to be set at any desired angle; by thus varying the widths and axes of the channels through which the water was withdrawn, the flow could be distributed so as to be uniform all over the baffle partition or irregular as desired. The final arrangement will be understood from Fig. 2. All the boards are fixed in the same inclined plane, but the edges of the boards are cut off obliquely, and they are so spaced apart that the open channels have a width of 7 cm. near the water-level, and lower down widths of 6 cm., 5 cm., and finally 4 cm., while the oblique spacings or apertures are 14 cm., 12 cm., 9.5 cm. and 7 cm. The result obtained was that the stream-line motion filled practically the whole basin, and that the stream lines were much less crowded, being nearly parallel near the top and more curved and further apart near the bottom of the basin. Eddies were not altogether avoided, but they were slight.

The arrangement was tested by adding sand grains of different sizes to the water, the amount of sand added in one experiment of 30 minutes ranging from 44 kg. to 61 kg. The sand was sorted into fine grains (up to 0.6 mm. diameter), medium (0.8 mm.), and coarse grain (1.5 mm.), 100 kg. containing 20 kg., 29 kg. and 51 kg. of the different grains; the average weights of the grains were: fine, 0.13 mg.; medium, 0.34 mg.; coarse, 0.75 mg. per grain. When the sand was thus introduced near the water-level, a little beyond the third row of gas pipes, the deposit consisted of 51 per cent. of the fine grains, 86 per cent. of medium, and 97 per cent. of coarse grains. The practical conditions are, of course, much less unfavourable, since all the sand comes in with the water, the cross-section of which is constricted to nearly half the height of the basin at the inlet. When the sand was introduced at half the height of the basin, or 15 cm. above the bottom, the figures improved very much, and were considered sufficiently promising to justify the construction, which worked satisfactorily during the summer, 1916. The actual amount of sand carried by the Borgne water varies from 0.4 gramme up to 1 gramme per litre, reckoning only sand grains above 0.3 mm. diameter. The settling in the basin is of course not uniform; the coarse particles are found near the water inlet, finer grains further off.

SAND-SETTLING BASIN FOR HYDRAULIC PLANTS.





Personal.—The Controller of Coal Mines has appointed Mr. Frank Pick, commercial manager of the London Electric Railways, as his assistant to deal with matters in connection with the London coal distribution scheme.—Messrs. The Coats Machine Tool Company, Limited, inform us that Palace Chambers, to which they had removed their offices from Caxton House, having also been commandeered by the War Department, for the use of the Food Controller, their address, from the 10th inst., will be Thanet House, Strand, W.C. 2. Their telegraphic address will remain the same, excepting that the indicator will now be "Estrand" instead of "Parl," whilst their new telephone number will be City 7081 (2 lines).—We are informed that Mr. Thomas W. Cherry has been appointed to the position of sole representative for Messrs. Cammell Laird and Co., Limited, in the North-East Coast district, which position was previously held by the late Mr. Joseph Johnson for many years. Messrs. Cammell Laird's Offices are at 32, Grainger-street West, Newcastle.—Owing to the Government having taken over Palace Chambers, the address of the Consolidated Pneumatic Tool Company, Limited, is now "Egyptian House," 170, Piccadilly, London, W. 1, where all communications should be sent. The London showrooms and repair works are at 73, 75, 79, 80, York-street, S.W. 1, near St. James's Park Station (District Railway), where pneumatic and electric tools can be seen in operation.

Changes in the Board of Admiralty.—The Secretary of the Admiralty makes the following announcement:—The King has approved the following changes in the Board of Admiralty: Vice-Admiral Sir Rosslyn E. Wemyss, K.C.B., C.M.G., M.V.O., to be Second Sea Lord, in succession to Admiral Sir Cecil Burney, G.C.M.G., K.C.B., who will be employed on special duty. Mr. Alan Garrett Anderson (late vice-chairman of the Wheat Commission) to be Controller in the vacancy created by the appointment of the Right Hon. Sir Eric C. Geddes, K.C.B., M.P., as First Lord of the Admiralty. On the appointment of Vice-Admiral Sir Rosslyn Wemyss the opportunity will be taken to rearrange the duties of the Second Sea Lord, who will be relieved of detailed administrative work connected with the personnel of the Fleet. It is also announced that Mr. R. F. Dunnell (secretary and solicitor of the North-Eastern Railway) has, with the approval of the directors of the North-Eastern Railway, accepted the appointment of Temporary and Additional Assistant Secretary of the Admiralty. It is further announced that Sir W. Graham Greene, K.C.B., has been invited by the Minister of Munitions to undertake the duties of Secretary of the Ministry. Sir Graham Greene, with the Prime Minister's approval, has accepted this invitation, and has vacated the office of Permanent Secretary of the Admiralty. An announcement as to his successor will be made later. In the meantime Sir Oswyn Murray, K.C.B., will act as secretary.

Award to Professor W. G. Fearnsides.—The annual general meeting of the North of England Institute of Mining and Mechanical Engineers was held last Saturday, the 4th inst., at the Wood Memorial Hall, Newcastle, when the G. C. Greenwell silver medal was awarded to Professor W. G. Fearnsides, of Sheffield University, for his paper on "Some Effects of Earth-Movement on the Coal-Measures of the Sheffield District (South Yorkshire and the neighbouring parts of West Yorkshire, Derbyshire and Nottinghamshire)."

The Russian Exhibition.—As part of their scheme for bringing before British manfuacturers and financiers the tremendous opportunities which are offered to the Allies in the development of the Russian market after the war, Messrs. R. Martens and Co., Limited, 149, Leadenhall-street, E.C., state that they are now organising a series of exhibitions in the most important centres of Great Britain. The period fixed for the London exhibition is from August 7 to 18, and it is being held at the Central Hall, Westminster, where a large number of diagrams and maps, illustrating the chief features of Russia's economic life, together with a representative collection of minerals from the Urals, are shown each day from 10 a.m. to 10 p.m. A lantern lecture dealing with different aspects of Russia's resources is given daily at 8 p.m.

German Baltic Shipping.—The German shipping concerns which trade between Germany and Scandinavian ports on the Baltic have done somewhat better during 1916. This to some extent has made up for the bad years 1914 and 1915, although the average dividend for the three years is only from 4 per cent. to 5 per cent., in isolated cases perhaps 7 per cent. The companies which have done best are the Renata concern in Stettin, Baltische Rederei in Flensburg, and the Vereinigte Bugair und Frachtschiffahrt in Hamburg. The greatest trade has been done in iron ore from Sweden. The boats of the companies dealing with the Baltic trade, however, represent about one-tenth of the aggregate German merchant navy, and that the remaining nine-tenths have fared very badly during the war is openly admitted on all sides.

The Dehydration of Peat.—With respect to the recent discussions on the utilisation of peat, we are reminded of the experiment of about fifteen years ago on the electro-osmotic dehydration of peat, dye-stuffs and other suspended matter. The originator of these experiments, Count Botho Schwerin, died last February. We were under the impression that his somewhat successful experiments on peat treatment had been abandoned, because he could not get rid of more than about 40 per cent. of the water by burning one-eighth of his peat for generating electricity. From the obituary notices we see, however, that the treatment had lately been improved and resumed. The general principle of the process is that when water contains suspended matter, colloidal or not, in addition to small proportions of electrolytes, the different electric charges which the particles and the liquid assume between electrodes make these constituents travel in different directions—the water generally to the kathode, the particles to the anode. The electrodes were made of wire gauze, and the diaphragms of porous silica, &c., and so arranged that the water could trickle through them. Schwerin worked first in the dye works at Höchst, later he founded the Electro-Osmose Gesellschaft; his partial success in purifying dyes, clay, and colloids like glue and albuminoids and promoting dialysis, *i.e.*, the separation of colloids from solutions, probably diverted his attention from the problem of drying peat. There are, however, no particulars available about his improved peat process. The electrolytic decomposition accompanying his osmose seemed to be unimportant.

SUGDEN'S SUPERHEATER FOR THE "STIRLING" TYPE OF BOILER.

CONSTRUCTED BY MESSRS. T. SUGDEN, LIMITED, ENGINEERS, LONDON.

Fig. 1.

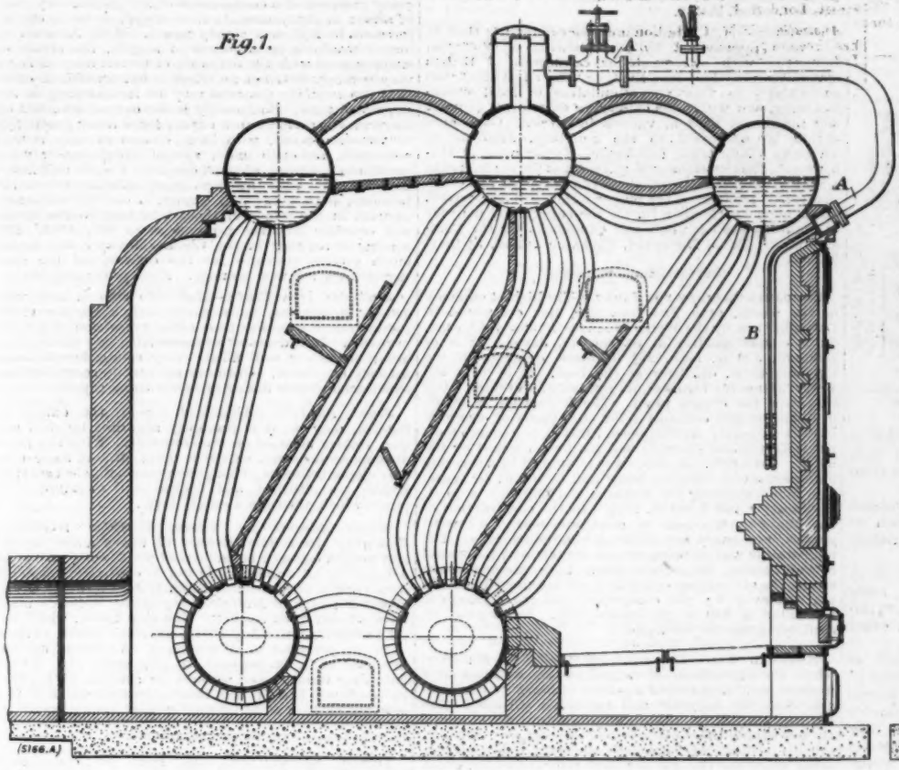
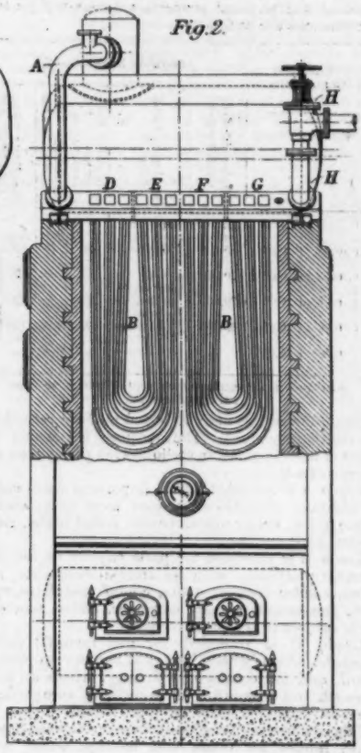


Fig. 2.



The usual arrangement of superheater fitted to a "Stirling" boiler is placed between the first and second bank of tubes. Hitherto this has been found to be the best position for a superheater, as the temperature in this chamber admits of a fair degree of superheat being obtained with a reasonable amount of superheater heating surface.

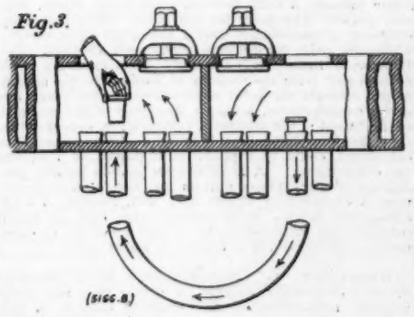
There are, however, well-known serious practical objections to fixing the superheaters in this chamber, owing principally to the very limited space available for cleaning, removing or replacing either boiler or superheater tubes. The type of superheater hitherto used for the purpose is arranged with the headers either above or below the two sets of circulating pipes connecting the steam and water space of the drums. If placed below, the expanded joints of the tubes, and the joints of the hand-holes affording access to the headers, are in the path of the flame and heated gases, which is for obvious reasons bad practice.

In the alternative arrangement the headers are placed outside the superheater pipes, being inserted between the circulating pipes. This has the advantage of affording better access to the superheater tubes, and also is a better protection to the joints, but makes a very inconvenient arrangement of superheater, owing to the tubes having to be threaded through the circulating pipes connecting the drums, and, further, the tubes have to be much longer for this purpose, and consequently a considerable amount of the heating surface of the superheater tubes is ineffective. There is, however, a further objection to placing the superheater tubes in the chamber between the first and second bank of tubes, as this increases the difficulty of taking out and replacing the boiler tubes as well as the superheater tubes.

The object of the new design of superheater illustrated on this page is to overcome these difficulties. This is accomplished by placing the superheater in the first chamber in close contact with the front wall of the boiler, and in such a position that access can be readily obtained for cleaning and inspection. It also avoids any complications in removing either boiler or superheater tubes.

Previous efforts in this direction have failed owing to the tubes in the ordinary design of superheater projecting too far into the chamber and burning out. The arrangement we now illustrate overcomes this difficulty by placing the superheater tubes in a single header, so arranged that the front and back rows are not more than about 4 in. apart, which prevents any excessive heat reaching the tubes.

Fig. 3.



The superheater header is divided into three compartments and consists of two double groups of U-tubes, one group being placed immediately alongside the other. The saturated steam from the boiler enters the group of tubes in the first compartment and passes out into the second, which in turn is connected with the third compartment, through which the steam passes to the outlet. Ample room is provided for taking out and replacing any of the superheater tubes, and access doors are provided in the headers, which are conveniently placed outside, so that a tube can, as illustrated in Fig. 3, be re-expanded or stoppered quite conveniently without going inside the boiler setting.

If a superheater tube should fail it is not necessary to shut the boiler down, as the tube can be plugged in a few minutes. For this purpose a steam stop valve is placed on the inlet side and one on the outlet side of the superheater, so that it is only necessary to discharge the steam from the superheater to re-expand or stopper a tube, which can be done in a few minutes without letting the steam out of the boiler, as is necessary in other designs where no valve is placed between the boiler and the outlet of the superheater.

Fig. 1 shows a sectional elevation of the boiler.

Fig. 2 shows the front elevation of the boiler and part section showing the superheater tubes.

Fig. 3 shows the arrangement for re-expanding, stoppering, or for removing and replacing tubes.

The steam enters from the boiler dome, through the valve and connecting pipes A, into the superheater B, and passes from the superheater to the main steam pipe through connecting pipe and valve H. In passing through the superheater the steam first enters the header in the compartment D, passing thence, through the first group of tubes B, into the compartment E F, and next through the second group of tubes B to the third compartment G, on which is mounted the outlet pipe and valve H. An access door is provided for inspection and removal of tubes.

The following are particulars of the working of this superheater adapted to a "Stirling" boiler at the Blaina Colliery. The boiler has a heating surface of 1,620 sq. ft. and a grate surface of 32 sq. ft., and is capable of evaporating under normal conditions of working about 6,500 lb. of water per hour. The working pressure is 160 lb. on the square inch, giving a temperature of 370 deg. F.; the superheat added to the steam at this temperature is 180 deg. F., making a total steam temperature of 550 deg. F.

This is a simple design of superheater, and one which should give good results; it has the advantage of easy accessibility, and raises no complications with regard to the boiler, as it does not interfere with the boiler itself as regards access for either removal of tubes, cleaning or inspection. All the joints are outside the path of the flame and consequently will not suffer deterioration from this cause. The makers of these superheaters are T. Sugden, Limited, of 180, Fleet-street, London, E.C., whose superheaters in connection with various types of boilers are well known.

The Erie Canal.—We read in the *Barge Canal Bulletin* that July 4, 1817, is one of the most memorable days in the history of American canals. On that day the first spadeful of earth was turned in the construction of the Erie Canal. The centenary of the event was celebrated on July 4 last.

American State Armour-Plate Plant.—We read in *The Iron Trade Review*, Cleveland, O., that Secretary Daniels has made the expected announcement that the construction of the proposed Government armour-plate plant at Charlestown, W. Va., has been delayed indefinitely, or until "some present needs of the Navy are furnished." This announcement is in line with what has been expected by the iron and steel industry and by those who have been keeping in touch with the subject since the announcement was first made.

UNITED STATES NAVY: NEW SPECIFICATIONS FOR STEEL CASTINGS.

New specifications governing the manufacture of steel castings have recently been issued by the United State Navy Department, says *The Iron Age*. The chemical and physical properties demanded by those specifications are as follow:—

Grade.	Chemical Composition. Not Over P.	S.	Physical Requirements. Minimum Tensile Strength.	Minimum Yield-Point.	Minimum Elongation, Per cent. in 2 in.	Minimum Reduction of Area.	Bending Tests. Cold Bend. Not less than
			lb. per sq. in.	lb. per sq. in.	p.c.	p.c.	deg.
F.	0.05	0.05	85,000	63,000	22	35	120
A.	0.05	0.05	80,000	45 per cent. of tensile strength obtained	17	20	90
B.	0.05	0.05	70,000		22	30	120
D.	0.06	0.05	60,000		22	30	120
C.	0.06	0.07	—	—	—	—	—

(B, D: about an inner diam. of 1 in.)

Note.—Class F castings may contain nickel or other alloying metals.

Grade C castings are not tested and are regarded as the least important. The purpose for which each grade is used is given in the following paragraphs from the specifications:—

Grade A is intended for all important parts subject to crushing stresses or surface wear only, such as hawse pipes, chain pipes, turret roller paths, engine guides, stoppers, &c.

Grade B is intended for parts subject to tensile or vibratory stresses, such as stems, sternposts, stern tubes, rudder frames, struts, engine bedplates, cylinders, gun-mount stands, carriages, slides, and other parts subject to the shock of recoil.

Grade C is intended for gun mounts, such as brackets, levers, wheels, &c., not subject to shock of recoil, and for commercial fittings, where structural strength and separation of watertight compartments are not involved, such as pipe flanges (other than bulkhead and deck), cagemast fittings, stowage lugs and clips, hinges for doors and hatches where watertightness is not involved, &c.

Grade D is intended for the same general purposes as Grade B, but where greater strength is required with equal ductility.

Grade F is intended for castings for gun yokes, gun-mount stands, carriage slides, deck lugs, &c., of large size.

The latest specifications of the Navy for structural steelwork, dated February, 1, 1917, demand not over 0·05 per cent. of sulphur and phosphorus in all steel castings used in yards and docks and similar work, and limit the sulphur to 0·045 per cent. for rivet steel for bridges and buildings.

It is known that in many cases it is difficult to meet a sulphur specification of not over 0·05 per cent. at present, even in acid open-hearth work. The intensive stress for output under which blast-furnaces and coke plants have had to operate has tended to increase rather than diminish the quantity of sulphur in the raw materials, thereby making it still more difficult for steel makers to meet specifications.

State Coal-Mining in Bavaria.—The Bavarian State is about to become possessed of the Friedrich Heinrich Coal Mining Company, Lintfort. The French shares in the concern will be liquidated and the State will, it is stated, acquire not only the 20,000,000 marks foreign share capital, but also the balance of some 2,000,000 marks in German possession. There has been some difficulty in extending the pits of the mine in question, but matters have mended the last few years. The coal is of the very best quality. This is the second important mining concern which lately has passed into the possession of the Bavarian Crown.

Bauxite, Lignite and Gas Works in Austria-Hungary.—The war has increased the importance of many natural resources. A very good bauxite for aluminium production occurs in Hungary in the Bihra district, it is said, the mineral containing up to 60 per cent. of alumina, 20 per cent. to 25 per cent. of iron oxide and silica, and some titanic oxide. The lignite of Petroseny, in the Hunyád Comitate, is described as equal to a fair quality coal; in 1913 the Hungarian railways took one-third of their fuel from those mines, and the proportion has increased very much since, whilst the Bohemian lignite of the Brüx district has gone back owing to the dearth of labour and means of transport. As regards gas works, we see in the *Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereins* that of 170 Austrian gas works 118 are municipal; coal-gas is made in 123 of these works, water-gas in 6, acetylene in 31, air-gas in 5, and oil-gas in 5 works.

COLONIAL ENGINEERING PROJECTS.

We give below a few data, taken from *The Board of Trade Gazette*, concerning a colonial engineering project, further information on which can be obtained from the Department of Commercial Intelligence, 73, Basinghall-street, London, E.C. 2.

Australia.—H.M. Trade Commissioner reports that he has been approached by the Institute of Victorian Industries with a request for catalogues of British manufacturers for its library. The Institute has particularly in view the stimulation of local manufacturing, and wishes for catalogues descriptive of plant and machinery used in various industries. Catalogues should be addressed to the secretary, Institute of Victorian Industries (Education Department), Melbourne. *The Commonwealth of Australia Gazette* publishes a notice by the Department of the Navy to the effect that sealed tenders, on the proper forms, will be received, up to noon on October 10, for the supply and delivery of pumping station plant and equipment for the Commonwealth Naval Dockyard, Cockatoo Island, Sydney, N.S.W.

Concrete Chimney for Japan.—The highest chimney in the world, says *The Iron Age*, was completed in December last by the Weber Chimney Company, Chicago, for a copper smelter at Sagonoseki, Japan. It is of concrete, 570 ft. high, 26½ ft. inside diameter at the top and 42 ft. diameter at the base. It is on a hill 430 ft. above the furnaces, its top being, therefore, 1,000 ft. above the copper plant. The foundation is 90 ft. in diameter and contains 2,700 cub. yards of concrete. It rests on gravel, and supports 6,000 lb. per square foot, the weight of the chimney and the force exerted by the wind. For 150 ft. the chimney is reinforced by a concrete lining separated from the outer wall by a 5-ft. air space. The flue connecting the furnaces and chimney is 30 ft. in diameter and 2,500 ft. long. In the construction of the chimney 400 tons of steel was used. All wind stresses are taken by vertical reinforcing rods. The temperature and shearing stresses are taken by horizontal rings encircling the vertical bars. Under the maximum strain, the stresses are calculated not to exceed 16,000 lb. per square inch; the compression on the concrete is calculated at 550 lb. per square inch. In erecting, all scaffolding was on the inside.

Natural Gas.—The town of Torda, in Hungary, where the exploitation of natural gas has assumed large proportions, has installed a system of heating by natural gas, both for domestic and industrial purposes. The bore holes are 52 km. (32 miles) distant from the town and the gas supply takes place through a steel pipe, 250 mm. (10 in.) in diameter. Amongst the many industrial concerns which use this gas is a large cement factory, which takes 150,000 cub. m. in the 24 hours; a brewery, a sugar factory, a soda factory, some brick works, &c., also use it. The price for the gas to these industrial concerns is exceedingly low, 1 heller per cubic metre; whilst the price for domestic purposes is 8 hellers. The Hungarian State Railways light their carriages with natural gas from the vicinity of Torda. As the supply of gas exceeds the local requirements, other plans are under consideration, amongst them one of delivering it to Budapest; the distance, certainly, is considerable, some 500 km. (300 miles), in spite of which the gas, it is calculated, could be supplied in Budapest at 7 hellers per cubic metre. A large electric station for the production of atmospheric nitrates has also been projected with a capacity of 20,000 h.p., and, further, a large aluminium works, in connection with both of which schemes test installations have been erected. (1 cubic metre = 35.32 cub. ft.; 1 heller = about $\frac{1}{10}d$.)

Germanium in Zinc-Blende.—When Clemens Winkler discovered, in 1886, in a new very rare silver mineral, argyrodite, of the Freiberg district, a new element which had the properties of the unknown element eka-silicon, predicted by Mendeleieff, he could only isolate a very small mass of the new metal germanium. Argyrodite is still very rare and scarce. Very small quantities of germanium were subsequently discovered in other minerals, all rare and complex. Spectroscopically Urbain, within recent years, detected germanium in certain blendes, and W. F. Hillebrand and J. A. Scherrer also found germanium while investigating the recovery of gallium from spelter. Last April Mr. G. H. Buchanan informed the American Chemical Society that he had definitely traced the germanium to a zinc oxide, obtained from blende from the Joplin district (Missouri) and Wisconsin. He had been aided in his search by A. A. Noyes, who worked out a test for the metal. This oxide seems to be a fairly rich raw material for germanium, and Buchanan can account for the fact. Carbon is known to reduce germanium oxide at red heat, and germanium, being not markedly volatile at 1,300 deg. C., remains behind when the metallic zinc is volatilised; the germanium then passes with the zinc oxide into the bags, and the blende seems to contain about 0.01 per cent. of germanium. The research was carried out in the laboratories of the New Jersey Zinc Company, of Palmerston, Pennsylvania, and the scientific study is continued in the Massachusetts Institute of Technology. As germanium, a grey-white metal of atomic weight 71.9, density 5.5, stands between carbon and silicon on the one side, and tin on the other, and resembles silicon in its electric and thermoelectric properties, which Benedicks investigated at Upsala in 1915, metallurgists may be glad to hear of a source of germanium. Gallium, it is interesting to note, the eka-aluminium of Mendeleieff, was also discovered in a zinc-blende by Lecoq de Boisbaudran in 1875.

NOTES FROM THE NORTH.

Glasgow, Wednesday.

Scotch Steel Trade.—Now that work has been resumed in all its intensity, steel makers in the West of Scotland report not only excellent business at the moment, but every prospect of a continuance of this satisfactory state of affairs in the immediate future, and, so far as can be foreseen, at high and steady prices. With America no longer available as a source of supply, the strain of keeping level with the demands of Government is being very severely felt, but no effort is left untried in order that the requisite material may be forthcoming at the stipulated time. So speedily is the output absorbed on Government account that export fades away practically to vanishing-point, with little chance of any revival meantime, although under special circumstances some small lots are being shipped direct to France and Italy. In connection with the question of ordinary mercantile business, both home and export, a certain uneasiness prevails in the minds of those who look to the future and consider how the problem is to be solved. The continued activity in the Clyde shipyards has meant much greater pressure for the delivery of the steel required for the new tonnage. Firm prices still hold.

Malleable Iron Trade.—Malleable iron is still very greatly in request, more particularly since the entire production of steel has been taken possession of for war purposes. This demand increases from day to day, and order books are well filled, every establishment being actively employed. Ordinary mercantile consumers are experiencing some difficulty in obtaining supplies.

Scotch Pig-Iron.—Abnormal though the output of pig-iron may be, it is promptly absorbed by steel and iron makers engaged on war contracts. With the home demand so insistent, export is quite off, and some time may elapse before any change can reasonably be expected. Orders are plentiful, and booked well in advance, at prices which maintain a steady level.

Wages Advance for Women Munition Workers.—Following the recent advance of wages made to men and youths engaged on industrial work, comes a similar advance to all women employed in controlled establishments and in uncontrolled establishments to which Orders of the Ministry of Munitions regulating women's wages have already been applied. The new Order, which will take effect as from August 15, provides for an advance of 2*s.* 6*d.* per week to all women of 18 years of age and over, and of 1*s.* 3*d.* per week to girls under 18. By this both time workers and workers on systems of payment by result will benefit, and these advances are to be paid in every case, in addition to the usual weekly earnings.

Dutch Shipbuilding.—In spite of considerable difficulties Dutch shipbuilding has increased very materially during the war, as will appear from the appended table, showing the tonnage in course of construction at Dutch yards at the end of the years mentioned:—

	Tons gross.
1913	172,000
1914	185,000
1915	406,000
1916	440,000

Standardising Motor Cycles in the United States.—We read in *The Iron Age* that, on the suggestion of the War Department, a number of motor-cycle engineers, representing the entire American motor-cycle industry, held a meeting at Washington early in July to consider the extent to which the parts of motor cycles can be made interchangeable. These experts, who met under the auspices of the Society of Automotive Engineers in co-operation with the Automotive Transport Committee of the Council of National Defence, agreed upon numerous immediate steps looking to the ultimate interchangeability of parts in motor cycles intended for use abroad. These parts will all be brought to stated dimensions, but no effort will be made to enforce these standards upon motor-cycle manufacturers. There is little doubt, however, that this movement will result in great progress toward the general standardisation of the entire industry.

American Boiler Plate Specifications.—As the result of an investigation by the Bureau of Standards of the requirements of the Steamboat Inspection Service for steel boiler plate, says *The Iron Age*, the interesting fact has been developed that the specifications heretofore in force have been unnecessarily severe and may safely be relaxed so as to increase the output without in any way lessening the safety of this material. One of the most important changes recommended by the Bureau of Standards is the raising of the sulphur limit in open-hearth steel from 0.04 per cent. to 0.05 per cent. No change is made in the phosphorus, which remains at a maximum of 0.04 per cent. On the recommendation of the Bureau the following conditions have been adopted also:—Two tension tests and one quench-bend test shall be made from each plate as first rolled from the billet, slab or ingot, the tensile-test pieces to be taken from the diagonal corners of the plate, and the quench-bend specimen to be taken from that part of the plate which represents the top of the billet, slab or ingot. The quench-bend specimen shall withstand, without fracture, being bent over until the ends are parallel and the inner radius equal to one and one-half times the thickness of the test specimen. A modified rule has, further, been adopted for determining the working pressure on flat surfaces of boilers.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

South Yorkshire Coal Trade.—With the resumption after the holidays only being slowly made at the pits in the South Yorkshire and North Derbyshire districts, the hard coal position has taken on a much stronger tone. Contract accounts are somewhat in arrears, though these are not as yet a serious matter, and good working in the next few days will put them right. Cobbles are fairly plentiful, but more steam and gas nuts could be used with advantage. Slacks meet a steady demand, but the holiday season in Lancashire is having effect upon this section. Householders are still eager for such quantities as dealers and merchants can forward them for storing purposes. Quotations :—Best branch hand-picked, 20*s.* 6*d.* to 21*s.* 6*d.*; Barnsley best silkstone, 18*s.* 6*d.* to 19*s.* 6*d.*; Derbyshire best brights, 18*s.* 6*d.* to 19*s.* 6*d.*; Derbyshire house coal 17*s.* to 18*s.*; best large nuts, 16*s.* 6*d.* to 17*s.* 6*d.*; small nuts, 15*s.* 6*d.* to 16*s.* 6*d.*; Yorkshire hards, 16*s.* 6*d.* to 17*s.* 6*d.*; Derbyshire hards, 16*s.* to 17*s.*; best slacks, 12*s.* to 13*s.*; seconds, 10*s.* 6*d.* to 11*s.* 6*d.*; and smalls, 7*s.* 6*d.* to 8*s.* 6*d.*, per ton at the pit.

Iron and Steel.—With practically all the works in the city closed for the holidays, extending in many cases until the early part of next week, considerable attention is being paid to the overhauling of plant and machinery. Much in the way of arrears has to be made up in this essential work, and the present is being utilised as the needed opportunity. It is stated that the official opinion on the matter of holidays was that we were well forward with the munitions output, and the authorities felt that all firms should give the full ten days unless there was emergency work of a very urgent nature. The workers themselves must find the interval very acceptable, and doubtless we shall reap the fruits of it at an early date when they return refreshed for the toil of the shop and the furnace. Large orders are on hand for marine and aeroplane work. Tool-makers are busy with work for ourselves and our Allies. Drills, reamers and milling cutters are being produced at a satisfactory rate. Mining machinery, both for home and colonial use, is wanted, and the orders coming to Sheffield are bigger than anything so far received and executed during the period of the war. The lighter trades have no new features at the moment. In the metal and material market business is temporarily without anything of outstanding interest.

NOBEL BROTHERS' NAPHTHA COMPANY.—The production during 1916 shows an increase in the output of naphtha of 24,000,000 poods on the previous year's production of 65,800,000 poods. The demand for all products has been very active; the sale of masut reached the high figure of 124,500,000 poods, and 575,000 poods of benzine were supplied to the war department. The receipts amounted to 228,700,000 roubles, against 106,145,000 roubles for the preceding year; a dividend of 40 per cent. was declared for 1916, against 30 per cent., 26 per cent., 26 per cent. and 22 per cent. for the preceding four years. (1 pood = 36 lb.; 9.4 roubles 1*l.*)

MACHINERY IN BRITISH MALAYA.—In 1915, according to the Malayan States Information Agency, a substantial increase was shown in the use of modern machinery in the mines, and in 1916 there was a further increase of 1,877 h.p. The following table of horse-power gives an idea of the nature of the machinery and appliances in use :—

	1916.	1915.
Steam	24,810	24,589
Steam-electric	4,255	3,020
Hydraulic	17,911	17,118
Hydro-electric	3,549	3,172
Suction gas	2,203	3,051
Oil engines	3,851	2,950
Oil-electric	1,495	1,697
	58,074	56,197

At the close of the year 14 bucket dredges, all in Perak, were in operation, and gave satisfactory results. Taking the local average of eight labourers per horse-power, the aggregate is equal to a labour figure of 464,582, against 449,576 in 1915 and 206,048 in 1913. This point has to be remembered when considering a drop in the manual labour supply.

TRADE BETWEEN THE UNITED KINGDOM AND CANADA.—The imperial trade correspondent at Winnipeg reports, under date June 30, that at a recent meeting of the Winnipeg Board of Trade (*i.e.*, Chamber of Commerce) a new standing committee was appointed with the object of promoting trade between the United Kingdom and Canada. This committee, which is to be known as the Imperial Trade Committee of the Winnipeg Board of Trade, is prepared not only to answer all questions by British manufacturers bearing on the trade within the Empire, but to receive, and have properly displayed, samples from any British manufacturer. By this means, it is thought, importers in Western Canada will have an opportunity of handling British-made goods which are suitable for that territory. Samples submitted can usually be sold, and the proceeds, less a small commission to cover incidental expenses, remitted to the exporter. The committee will also endeavour to establish connections between the importer and manufacturer, or the importer and agent. Communications from the British firms should be addressed to the secretary, Imperial Trade Committee of the Winnipeg Board of Trade, Winnipeg.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—The Cleveland iron market shows no change of moment. Heavy deliveries of Cleveland pig-iron are going steadily forward to Scotland under the August allocations, and a gratifying feature is the substantial demand for forge quality for customers North of the Tweed. Only a little while ago forge was rather a drug on the market and stocks accumulated considerably, but now that it is being freely and advantageously employed in the manufacture of basic iron stocks have fallen to quite narrow proportions. Furnaces are working excellently, and, as a result, are producing larger proportions of better qualities of iron and less forge. Approaching local holidays have curtailed North of England demand for Cleveland foundry iron. Export trade is quiet, but with iron quite plentiful, and prospects of improvement in the tonnage situation, hope is expressed that some expansion of foreign business will be experienced in the near future. For home consumption No. 3 Cleveland pig-iron, No. 4 foundry and No. 4 forge are all quoted 92*s.* 6*d.*, and No. 1 is 96*s.* 6*d.*; and for shipment to France and to Italy No. 3 is 102*s.* 6*d.*, No. 4 foundry 101*s.* 6*d.*, No. 4 forge 100*s.* 6*d.*, and No. 1 107*s.* 6*d.*

Hematite Iron.—Little new is ascertainable concerning the East Coast hematite branch of trade. Continued careful distribution under official organisation assures adequate supplies to home customers, but after these have been satisfied there is little iron left for sale abroad. Home contracts continue to be made from time to time, but new foreign business is very difficult to arrange. Against old contracts shipments to our Allies are proceeding fairly well, and promise to improve, but there are very considerable arrears to be made up. Nos. 1, 2 and 3 are 122*s.* 6*d.* for home use, 137*s.* 6*d.* for shipment to France, and 142*s.* 6*d.* for export to Italy.

Coke.—There is heavy local demand for coke, and though there is a lot on the market values are upheld. Descriptions needed for the blast-furnaces in the North-Eastern district command full rates, average sorts realising 28*s.* at the ovens, and qualities low in phosphorus 30*s.* 6*d.* at the ovens.

Manufactured Iron and Steel.—Manufacturers of finished iron and steel experience difficulty in coping with heavy Government requirements and large and increasing demands of the shipyards. Pressure for delivery is enormous, and producers are employed to their utmost capacity. Exports are very strictly controlled, and very little material is now going either to India or the Dominions, most of the shipments allowed being for the Allies. Quotations are steady. To home customers common iron bars are 13*l.* 15*s.*; best bars, 14*l.* 2*s.* 6*d.*; best best bars, 14*l.* 10*s.*; iron ship plates, 15*l.* 10*s.*; iron ship angles, 13*l.* 15*s.*; iron ship rivets, 18*l.*; packing iron and steel (parallel), 13*l.*; packing iron and steel (tapered), 15*l.* 5*s.*; steel bars (no test), 14*l.* 10*s.*; steel ship plates, 11*l.* 10*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; steel ship rivets, 20*l.* and upward; steel boiler plates, 12*l.* 10*s.*; steel joists, 11*l.* 2*s.* 6*d.*; and heavy sections of steel rails, 10*l.* 17*s.* 6*d.*

ROLLING MILLS FOR FRANCE.—Inquiries have been sent from France to the United States, says *The Iron Trade Review*, Cleveland, Ohio, for 96-in. and 74-in. sheared plate mills and a 42-in. universal plate mill, to be electrically driven. The specifications include three main mill motors, 100 small motors, shears, roll tables, and from 9 to 15 heating furnaces. Lifting equipment, including 12 electric cranes, having capacities ranging from 10 tons to 50 tons, will probably be bought in Europe. The name of the prospective purchaser, now engaged in the manufacture of ship plates and munitions, has been withheld.

GRAPHITE FOR LUBRICATION.—The artificial graphite for lubrication which Mr. Acheson introduced ten years ago under the names of oildag and aquadag stimulated attempts to convert natural graphite into its unctuous, pure variety by other means than by the heat of the electric furnace. From a paper presented by Professor Holde, of the Materialprüfungsamt, to the Bunsen Gesellschaft (*Zeitschrift für Elektrochemie*, April 1, 1917), we see that the chemical works of E. de Haen are supplying such a graphite, which they call kollag. It is prepared after the method of Dr. Karplus, by treating ordinary graphite with acids and other chemicals, which extract the mineral impurities and render the graphite colloidal. The communication is interesting in another respect as well. In testing kollag and comparing it with oildag, Holde first mixed the kollag with benzene and acetic acid; the graphite then settled sufficiently in seven hours to separate the carbon from the liquid. A better way was found by filtering the kollag through fuller's earth or powdered asbestos. It was, of course, known that such finely divided mineral matter will, like charcoal, absorb suspended impurities which pass through a filter; turbid wine can, for instance, be cleared in this way. But that mixtures of oil and the very finest graphite particles, mostly less than 1 μ in diameter, could be completely cleared by the aid of fuller's earth is rather surprising. It is often exceedingly difficult to clear oily fluids sufficiently for examination. The kollag stood the tests well, as well as some samples of oildag; one sample of oildag proved superior to all the other oildags and kollags, but without knowing the history of all his samples Holde did not wish to say anything as to the relative merits of the two lubricants.

NOTES FROM THE SOUTH-WEST.

Cardiff.—Towards the end of last week the pressure of shipment on account of the authorities has been rather heavy, on account chiefly of the impending holidays. The Welsh miners having decided to take three days' holiday—instead of two as urged by the Admiralty—the production this week will not exceed 35 per cent. to 40 per cent. of a normal week's quantity. An opportunity is, however, afforded by this respite of disposing of any surplus stock which factors may have on hand. Pitwood still remains weak, but the supplies of home-grown timber are increasing, and are rapidly approaching a rate of 2,000 tons a week.

Newport.—Even before the holidays idle conditions prevailed, and there was hardly any business done till Thursday, when the collieries reopened, but it was anticipated that practically all this week's output would be taken up on official account.

Arrears of Coal Contracts.—Mr. Finlay A. Gibson, the secretary of the District Coal and Coke Supplies Committee for South Wales and Monmouthshire, has addressed to local authorities and other coal consumers in South Wales an important circular dealing with the question of the effect of the recent directions of the Coal Controller for the sale of coal on the arrears under contracts entered into prior to June 29. In this circular he states that he has been instructed by the Controller of Coal Mines to say that the latter "proposes to arrange that existing contracts in which there are arrears in deliveries outstanding on June 29 shall be submitted to local committees constituted of three coalowners and three exporters for the purpose of deciding whether such arrears may be supplied at the contract prices or are to be regarded as cancelled." The committees, in coming to a decision, are instructed by the Controller to take into consideration the following: (1) Whether the coal was already sold abroad (or, in the case of bunkers, to shipowners) prior to June 29 and there is an obligation in the contract to deliver; (2) whether arrears were due to colliery owners' fault or arrangements with colliery owners; (3) whether any deliveries were made during the three months prior to June 29, 1917; and (4) whether the purchaser, while failing to take deliveries, has bought improperly elsewhere. In the first two cases the Controller states there will be no question as to the right of the purchaser to the delivery of the arrears, but other cases will have to be decided on their merits, and the third and fourth considerations will assist the committees in deciding the reasonableness of each application, from the point of view of an undue hardship. It is suggested that the committees shall at the same time bear in mind that: (*a*) Lack of tonnage cannot in itself be regarded as establishing the claim to the delivery of arrears, and that, (*b*) generally speaking, arrears of speculative contracts should be cancelled. Joint committees of coalowners and exporters, with Sir T. J. Hughes as independent chairman, have been appointed to deal with all contracts for coal for shipment under parts two and three of the directions. It is laid down that "No collieries shall deliver arrears outstanding on June 29 except in cases sanctioned by the committee, and when application is made to the War Trade Department for licence to export such coal, evidence must be produced that the sanction of the committee to the delivery of the arrears has been obtained." The coal exporters are aggrieved at this further restriction on what they regard as their rights, because the proposals of the Controller are considered a vital departure from the conditions in the original scheme of June 28 last. It is pointed out that in the directions of June 28 there was a definite undertaking given that all contracts entered into before May 1, 1917, were not to be interfered with, and the new ruling has occasioned a good deal of perturbation on the Welsh coal markets.

Miners for the Army.—The scheme for the recruitment of miners for the Army was considered at a conference of delegates representing nearly 150,000 colliery workers, held at Cardiff the latter end of last week. According to this scheme 4,575 are required from the Welsh coalfield. Though the scheme has been adopted by the Miners' Federation of Great Britain, the delegates at Cardiff rejected it by 236 to 25, and it was afterwards resolved to take a ballot of the coalfield on the subject. The South Wales miners have, unfortunately, come into unenviable notoriety more than once since the commencement of the war. In fairness to the mass of the workmen, however, it should be stated that these disconcerting decisions are come to at conferences of delegates, who oftentimes do not give expression to the views of the men whom they are supposed to represent. These delegates usually receive their mandates from miners' lodges, which are attended by only the smallest fraction of the men, a dozen or so of the more aggressive local spirits having it all their own way even at centres where thousands of men are employed. The Commissioners who recently held an inquiry into the industrial unrest have certainly not probed the problem as far as South Wales is concerned. There is in South Wales a small, militant and ambitious number of young men who have been taught the elements of a certain type of sociology and political economy at the Central Labour College or Ruskin College, whose avowed object is to create discontent.

ENGINEERING AND MINING LADY STUDENTS.—The Paris journal, *Le Génie Civil*, states that by a decision of the Minister for Commerce and Industry, young girls are to be admitted as students to the Ecole Centrale, the French engineering college. They are to be admitted in other French technical schools, the Ecole Supérieure des Mines, among others.

THE VAMMA POWER STATION ON THE GLOMMEN RIVER, NORWAY.

(*For Description, see Page* 137.)

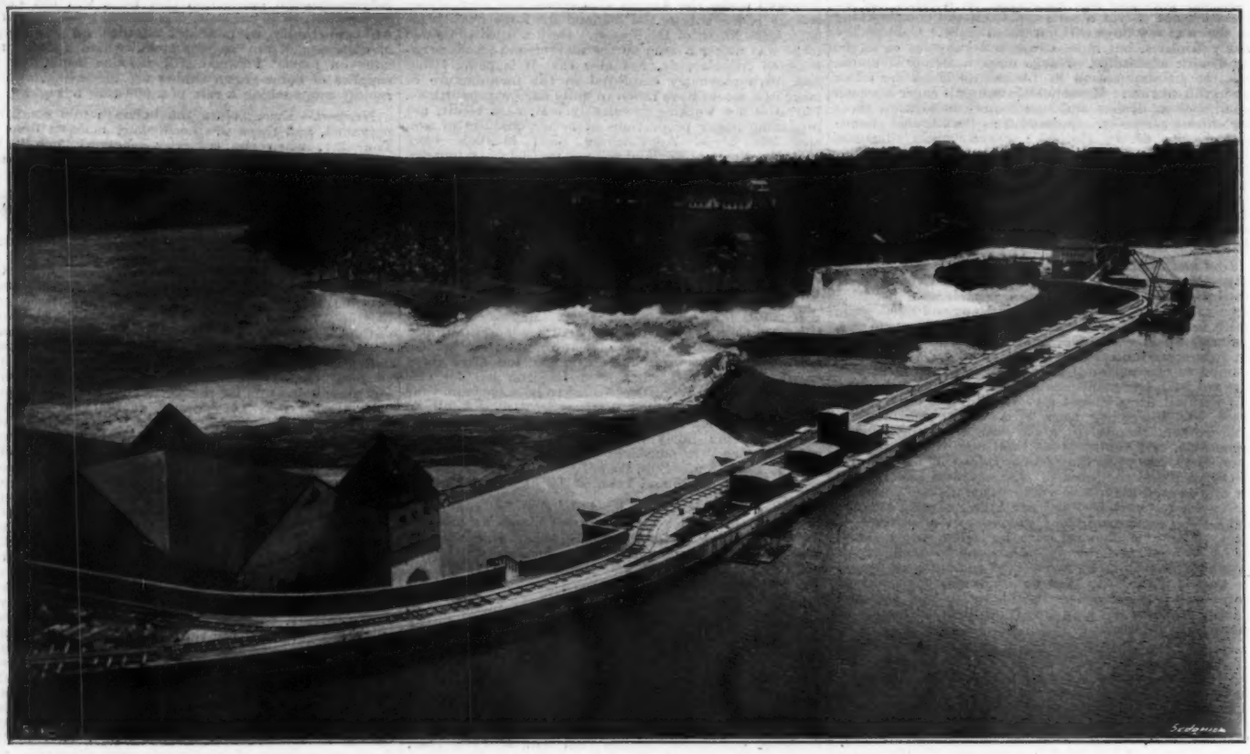


Fig. 10. View of Reservoir and Crest of Dam.

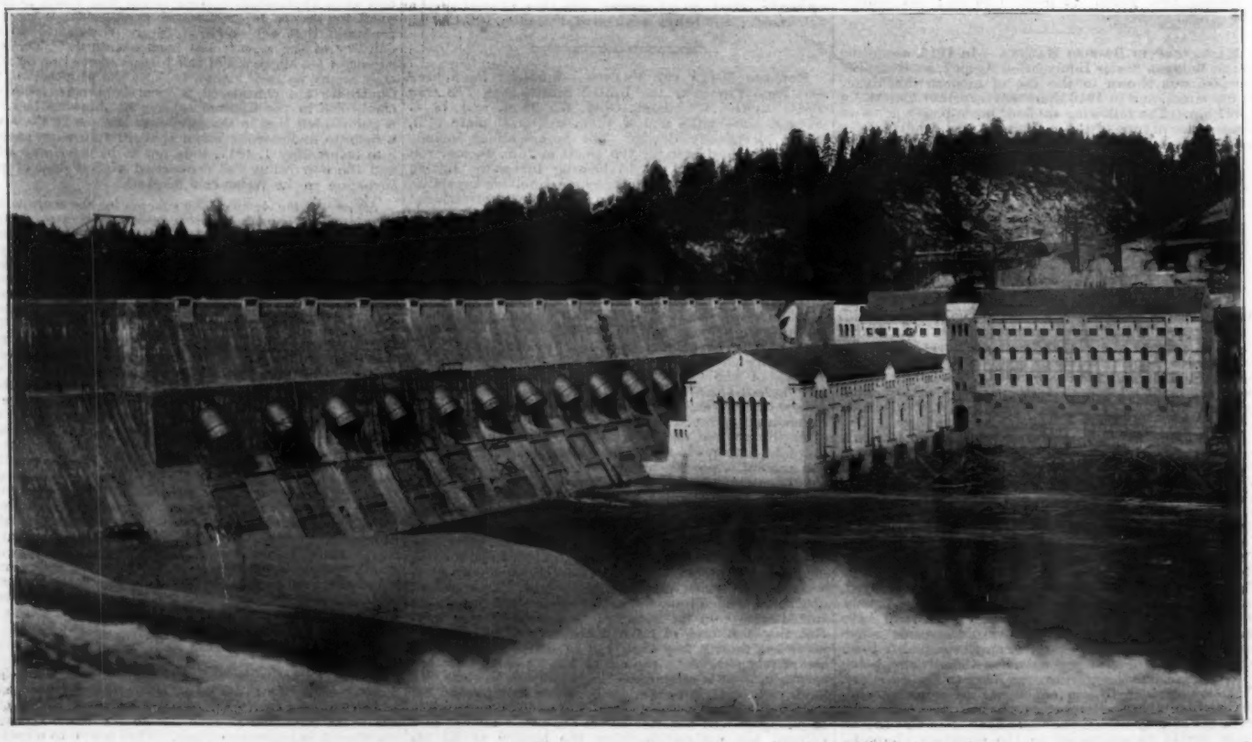


Fig 11. View of Dam from Below, showing Power House and Transformer Station.

THE VAMMA HYDRO-ELECTRIC POWER ST

(For Descrip

Fig. 1.

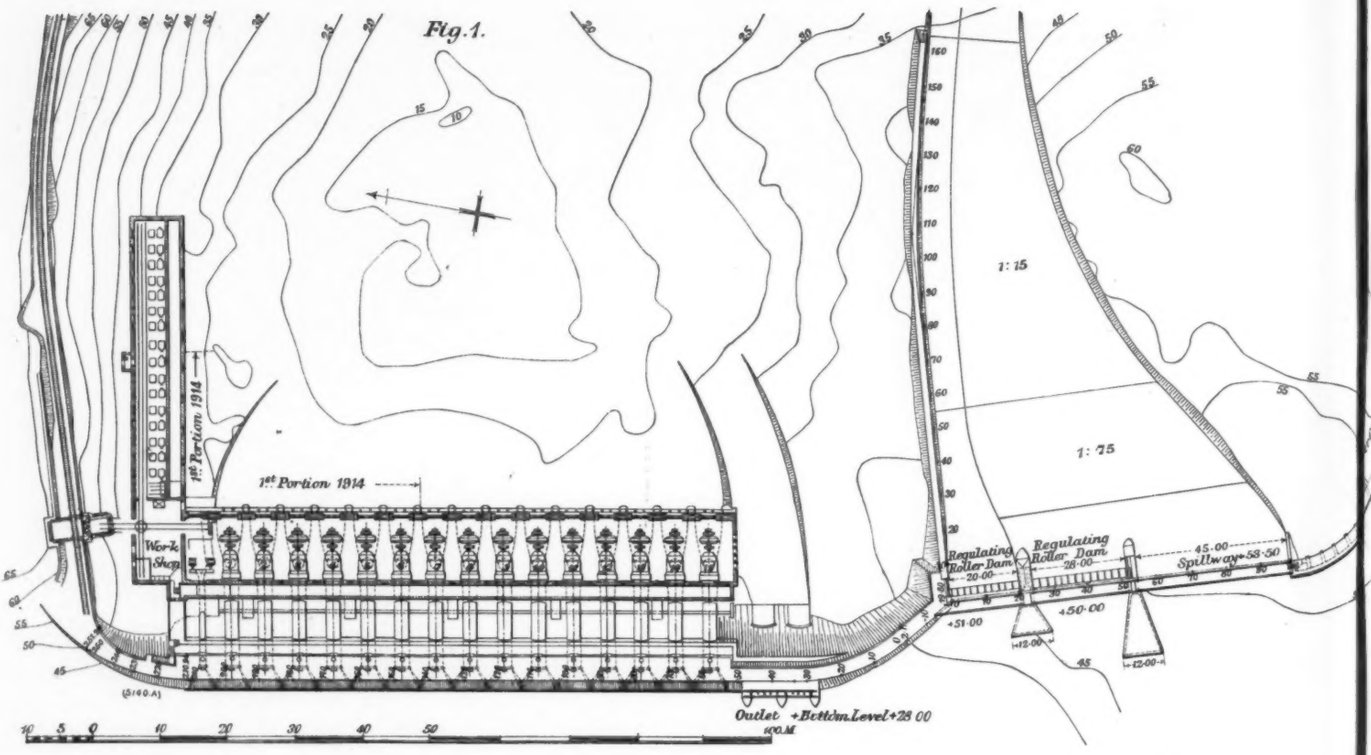
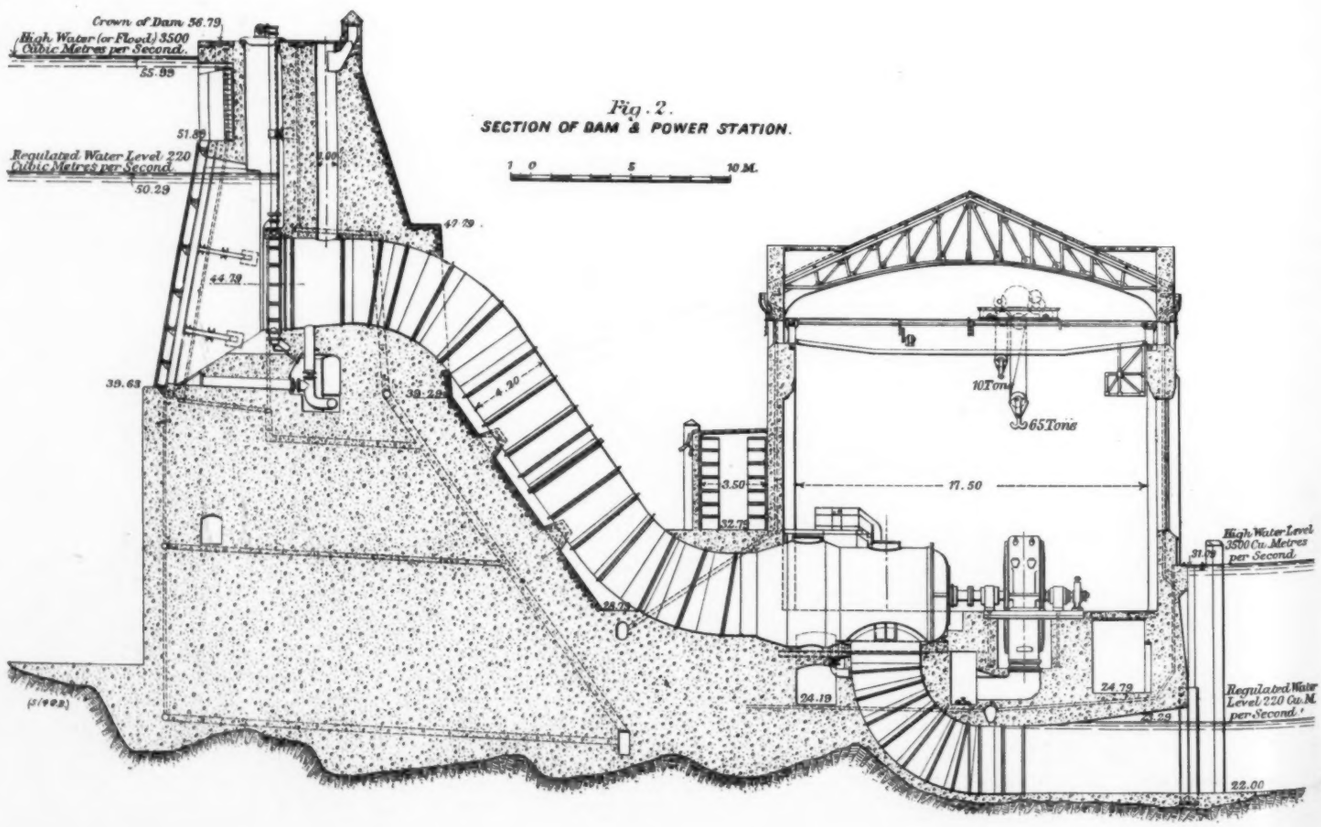


Fig. 2.

SECTION OF DAM & POWER STATION.



R STATION ON THE GLOMMEN RIVER, NORWAY.

(For Description see Page 137.)

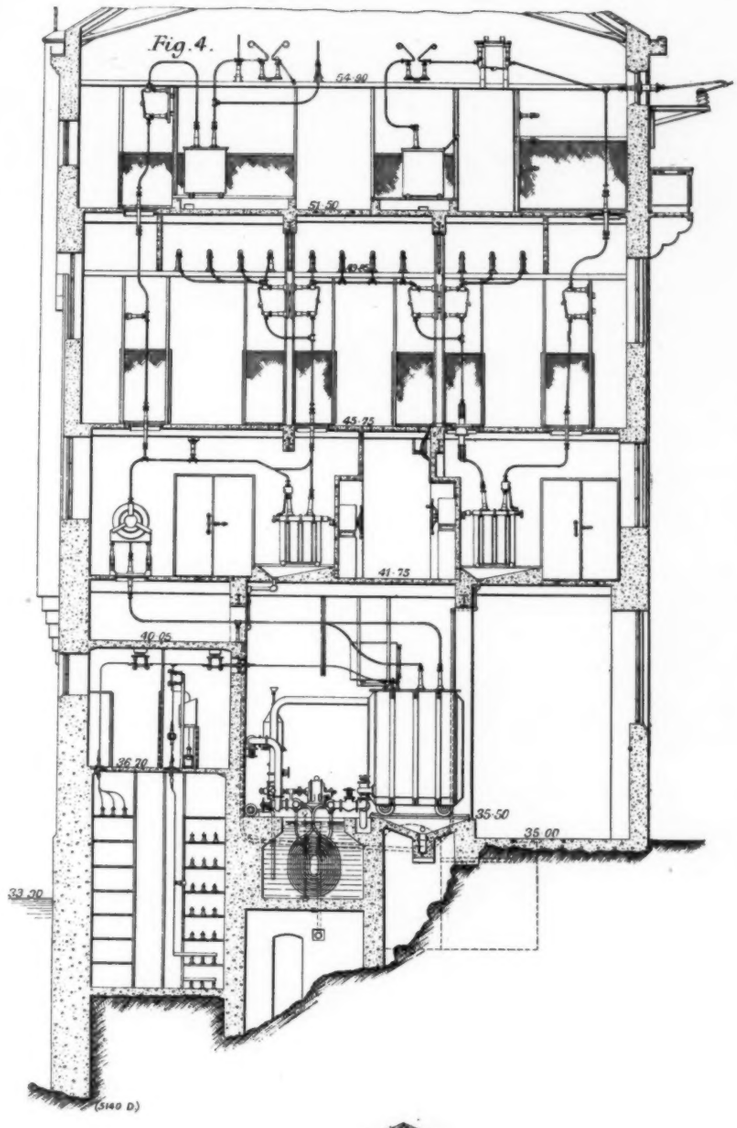


Fig. 4.

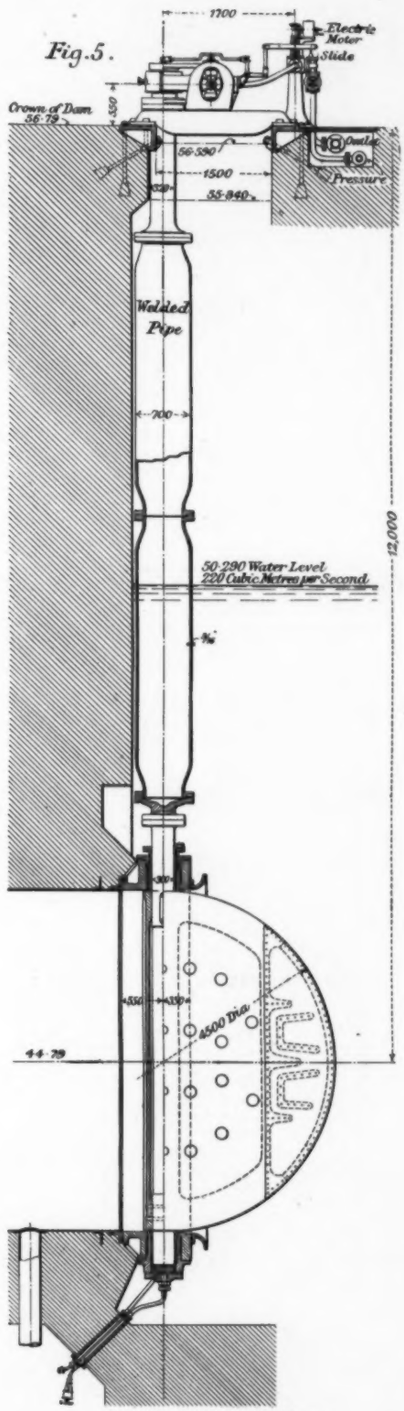


Fig. 5.

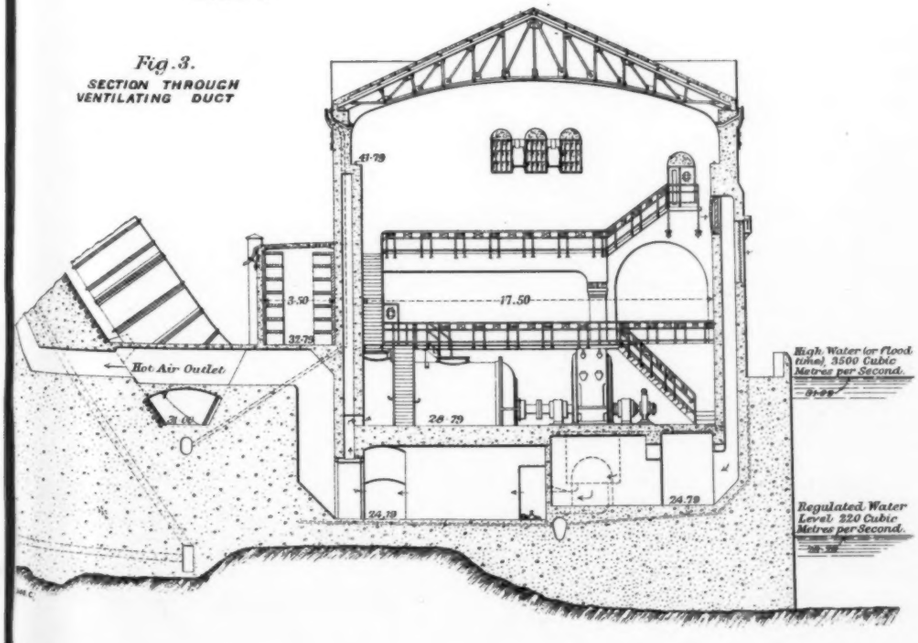


Fig. 3.
SECTION THROUGH VENTILATING DUCT

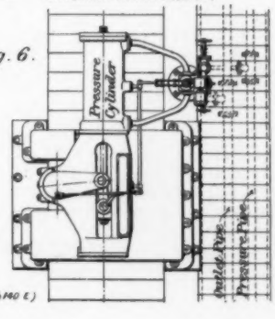


Fig. 6.

AGENTS FOR "ENGINEERING."

AUSTRALIA: Gordon and Gotch, Limited, Melbourne; Sydney; Brisbane; Perth. Turner and Henderson, Sydney, N.S.W. T. Willmett and Co., Townsville, North Queensland. W. C. Rigby, Adelaide, South Australia, Melville and Mullen, Melbourne, Victoria.
CANADA, Toronto, Ont.: Wm. Dawson and Sons, Manning Chambers. Montreal: Sells, Limited, 302, Shaughnessy Building, McGill-street.
EDINBURGH: John Menzies and Co., 12 Hanover-street.
FRANCE, Paris: Boyveau and Chevillet, 22, Rue de la Banque. For Subscriptions and Advertisements, Librarie B. Tignol, 53bis, Quai des Grands-Augustins, Paris. Also for Advertisements, Agence Havas, 8, Place de la Bourse.
GLASGOW: William Love.
INDIA, Calcutta: Thacker, Spink and Co. Bombay: Thacker and Co., Limited.
ITALY: U. Hoepli, Milan, and any post-office.
LIVERPOOL: Mrs. Taylor, Landing Stages.
MANCHESTER: John Heywood, 143, Deansgate.
NEW ZEALAND: Gordon and Gotch Proprietary, Limited, Wellington, Auckland and Christchurch.
NORWAY, Christiania: Cammermeyer's Boghandel, Carl Johans Gade, 41 and 43.
ROTTERDAM: H. A. Kramer and Son.
SOUTH AFRICA: Central News Agency, Limited, Head Office—Johannesburg; and Pretoria, Cape Town, Port Elizabeth, Bloemfontein, Durban, and their various branches and bookstalls throughout South Africa. Also Cape Town: Wm. Dawson and Sons, 31, Longstreet.
TASMANIA: Gordon and Gotch Proprietary, Limited, Launceston: Hobart.
UNITED STATES: For Subscriptions, New York: W. H. Wiley, 432, Fourth Avenue. Chicago: H. V. Holmes, 957-958, Monadnock Block.
For Advertisements, J. S. Allan, 508, Stratford Avenue, Bridgeport, Conn., U.S.A.

ADVERTISEMENT RATES.

The charge for advertisements is three shillings for the first four lines or under, and eightpence for each additional line. The line averages seven words. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

Advertisements intended for insertion in the current week's issue must be delivered not later than 5 p.m. on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received not later than 1 p.m. on Tuesday in each week.

SUBSCRIPTIONS, HOME AND FOREIGN.

REVISED RATES.

"ENGINEERING" may be ordered from any Newsagent in town or country and at railway book-stalls, or it can be supplied by the Publisher, post free, at the following rates, for twelve months, payable in advance:—

For the United Kingdom	£2 4 6
For Canada—	
Thin paper copies	£2 0 6
Thick " "	£2 5 0
For all other places abroad—	
Thin paper copies	£2 5 0
Thick " "	£2 9 6

When foreign subscriptions are sent by Post-Office Orders, advice should be sent to the Publisher.

All accounts are payable to "ENGINEERING," LIMITED. Cheques should be crossed "Union of London and Smith's Bank, Limited, Charing Cross Branch." Post-Office Orders should be made payable at Bedford-street, Strand, W.C. 2.

Offices for Publication and Advertisements, 35 and 36, Bedford-street, Strand, London, W.C. 2.

We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.
TELEPHONE NUMBERS—3063 and 8568 GERRARD.

CONTENTS.

	PAGE
The Vamma Power Station, Norway (*Illus.*)	137
The Railway Problem	139
The Arrangement of Machine Shops.—No. XVI (*Illus.*)	140
Industrial Notes	144
The Relation between Atomic Numbers and Atomic Weights (*Illus.*)	145
Wanted: A National Association of Engineering Foremen	145
Corrosion of Condenser Tubes	145
Sand-Settling Basin for Hydraulic Plants (*Illus.*)	146
Sugden's Superheater for the Stirling Type of Boiler (*Illus.*)	147
United States Navy: New Specifications for Steel Castings	148
Colonial Engineering Projects	148
Notes from the North	148
Notes from South Yorkshire	149
Notes from Cleveland and the Northern Counties	149
Notes from the South-West	149
The British Shipping Situation	151
The Strength of Copper Alloys	152
The Reports on Industrial Unrest	152
The Waste and Control of Natural Gas (*Illus.*)	152
A Record of Success in Municipal Tramways	155
Notes	155
Literature	156
Books Received	158
The Price of Cargo Steamers and Sailing Vessels	158
Low Temperature Carbonising and Some Products (*Illus.*)	159
Catalogues	161
ENGINEERING Patent Record (*Illus.*)	162

With a Two-Page Plate of the VAMMA HYDRO-ELECTRIC POWER STATION ON THE GLOMMEN RIVER, NORWAY.

NOTICE OF MEETING.

THE MINING INSTITUTE OF SCOTLAND.—Saturday, August 11, at 3 p.m., in the Royal Technical College, George Street, Glasgow. Mr. G. I. Kerr's paper on "The Higher Training of Colliery Managers" will be discussed. Mr. George Gibb will read a paper on "Intensive Mining in Thin Seams."

NOTICE.

Owing to the recent Government restrictions, and to the enormous increase in the price of paper occasioned thereby, the Proprietors of "ENGINEERING" are compelled to advance the price of this Journal from 6d. to 8d. per copy. This increase dated from and included the issue of Friday, March 16. The change will not apply to unexpired subscriptions.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper, and of the consequent shortage of supplies, readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk. Owing to the scarcity of paper it will be impossible in future fully to provide for a chance demand for this Journal.

ENGINEERING.

FRIDAY, AUGUST 10, 1917.

THE BRITISH SHIPPING SITUATION.

THERE is no need for anxiety regarding British shipping, so far as the submarine campaign goes. When the present situation of our mercantile fleet is considered in all its bearings, it is found that the shortage in tonnage is due not so much to the war wastage as to the unavoidable absorption of tonnage for war purposes. The fleet of the United Kingdom prior to the war totalled between 17,000,000 and 18,000,0000 tons; to-day it is a little over 15,000,000 tons, notwithstanding the fact that mercantile shipbuilding output for all the three years of the war was little more than one-third of the pre-war output. Indeed, had it been possible to maintain the former rate of production there would actually have been an increase. This augurs well for the future, when it will be possible to increase the amount of material and labour available for mercantile shipbuilding. And in this connection it is satisfactory that the first of the fleet of the standard ships of 8,000 tons deadweight capacity will be ready this month, and the others will follow in rapid succession.

The real difficulty is that about 6,500,000 tons of the total fleet has been absorbed to meet the needs of the British Navy and Army, our Allies, and the British Dominions across the sea. One million more tons of our shipping engaged on certain work cannot carry peace exports, as war material fills the holds, but it is available for imports. Thus it may be said that so far as exports are concerned less than half the fleet is available for commerce. The tonnage required for war service may seem high, but this is easily explained when consideration is given to the number of auxiliary cruisers, of hospital ships, of coal and oil carriers, and of transports required for war work. In the first two and a quarter years of the war, for instance, 8,000,000 men had to be transported across the seas, 9,420,000 tons of supplies and explosives, 1,000,000 horses and mules, and of petrol alone 47,500,000 gallons, while of sick and wounded men over a million were carried.

It has been felt, however, that, owing to the relatively small proportion available for trade, some system of co-ordination is essential in order to secure the maximum efficiency from the available ships, and to ensure the employment of every vessel in the manner and on the terms, as to rate of freight, most consistent with the national interests. The Government have therefore now taken complete control of all merchant shipping, and the result is thus semi-officially stated:—With the exception of a few vessels engaged in distant waters on work which is vital to British Colonies and of vessels chartered to France and Italy, the British Government has requisitioned for hire at Government rates about 97 per cent. of the ocean-going tramps on the United Kingdom Register. All British liners have been requisitioned and are being run for Government account. The owners receive hire at Government rates and the profits derived from private freight carried at market rates go to the Government and not to the shipowner. Every ocean-going voyage of British steamers is now directed by the Government, who have regard only to the question of how they can obtain essential imports from the nearest source, and disregard both the interests of the shipowner and the exporter. Many trades built up in distant waters and sustained by British industry have had to be abandoned to neutral owners, who gladly seek employment for their vessels in areas immune from war risk. The coastal traffic round the shores of the United Kingdom is being subjected to a searching review for the purpose of withdrawing vessels which can be utilised for ocean-going work, and of bringing about a limitation of rates wherever possible.

The owners are patriotically co-operating in this movement, and their organisations are to be pooled, while their staffs and resources are placed at the disposal of the Government for running the requisitioned ships. This in itself involves a sacrifice, as in many instances the trades built up by the shipowners must suffer severely from the depletion of shipping available for such routes, owing to the diversion of the steamers for other trades where it is possible to attain higher efficiency, as measured by the tonnage of imports per unit of time occupied. This, however, is only a small part of the disinterested action of the shipping community, and we must never for a moment forget the risks run by officers and crew in connection with the navigation of ships through dangerous waters, and, we may also add, the success obtained in combating enemy submarine boats. The owners of ships, too, have also shown in most cases a disinterested acquiescence in limitations imposed. Liners have been diverted from long-voyage routes, particularly in the case of India and the Far East, to short-distance trades, while a great volume of profitable trade between foreign countries, in which from 2,000,000 to 3,000,000 tons was formerly engaged, has had to be handed over to the ships of neutral countries. The owners of coasting ships, too, have suffered by the restriction of trade around the coast, particularly in respect of coal-carrying.

Already considerable advantage has been gained by the limitation of exports and imports. Before the war we were importing at the rate of about 58,000,000 tons per annum, but last year the imports fell to 43,000,000 tons, and this year they will be considerably less. Of the 58,000,000 tons rather less than a quarter was foodstuffs; the remainder was raw and other material for peace requirements. Last year, however, two-thirds of our supplies were foodstuffs, munitions of war, and material for the manufacture of munitions, leaving only about 14,000,000 tons for productive industries, as compared with upwards of 40,000,000 tons in pre-war times. In the present year it would seem that we are likely to get even less than the 14,000,000 tons for productive industries. The total imports in 1913 were valued at 769,000,000*l.* sterling, of which about 94,000,000*l.* came from the countries which are now enemies. In 1916 our imports were valued at 949,000,000*l.* sterling, none of which came from enemy countries. The rise in price accounts for a large part of the phenomenon of an increase in value with a decline in bulk from 58,000,000 to 43,000,000 tons; on the basis of pre-war prices the cost would have been about 800,000,000*l.* sterling. This is due to the different class of commodity being imported, a far higher price being paid for the unproductive material of war which circumstances have compelled us to substitute for the imports of peace time.

The value of our exports of produce and manufactures in the year prior to the war was 525,000,000*l.* sterling, while last year they were valued at 506,000,000*l.* sterling; but if the prices had remained the same as in 1913 the total would only have been 386,000,000*l.* sterling. The export trade has therefore been reduced by about 26 per cent., 10 per cent. having been exports to our present enemies, and the remainder to other parts of the British Dominions, to our Allies, and to other foreign countries. Our exports to Allies have increased to

some extent, but this affords no substitute for the loss of permanent trade. Our exports to other foreign countries and to the Dominions oversea have fallen off in value by about 100,000,000*l.* sterling, representing on pre-war values 337,000,000*l.* sterling—nearly one-third of the total.

THE STRENGTH OF COPPER ALLOYS.

New alloys, both ferrous and non-ferrous, showing remarkable properties under the ordinary laboratory tests, are being patented almost daily. Engineers have, however, learnt by much costly experience that the only really reliable method of determining the structural value of a new material consists in an actual trial of it. Material which in the laboratory appears extraordinarily ductile at times fractures spontaneously, the apparently non-corrodible metal wastes away with dangerous rapidity, and the alloy which in the testing machine has shown a high elastic limit, at times gives way under absurdly low stresses when embodied in an actual structure. Indeed many of these depressing experiences were recorded with mild steel when it first began to be extensively employed. Plates riveted into bridges or boilers have split spontaneously during the dinner hour, although subsequent tests of the material have shown good ductility even in the immediate neighbourhood of the fracture. No entirely satisfactory explanation of these mysterious failures has been forthcoming as yet, although accumulated experience has provided us with certain working rules, little better, indeed, than rules of thumb, by due observance of which the frequency of these mysterious failures has been reduced to a minimum.

Equally extraordinary failures have been by no means infrequent with copper alloys, but as these have never been used on anything like the same scale as steel, they have attracted less attention. Nevertheless, there have been frequent instances in which drawn tubes and rods of brass have split spontaneously in store, or after but a few weeks' or days' service. Experience has enabled manufacturers to minimise the risk of these "season cracks" in the case of such sizes of tubes and rods as are produced in large quantities, but equal success has not been attained in other cases. Unfortunately there is little inducement for either the maker or the user to publish to the world these disconcerting experiences, and many costly failures have accordingly not even served to add to the general stock of technical data. Special interest attaches, accordingly, to a series of papers* published in America during the past three years by Mr. A. D. Flinn, deputy chief engineer to the Board of Water Supply, New York City, and by Mr. Ernst Jonson, engineer-inspector to the same board.

Since the Catskill aqueduct was to form permanently a principal component of the New York water supply, it was considered desirable to use in its construction only the most durable materials, the additional capital cost involved being of little importance in view of the greater security attained, and of the expected reduction in the ultimate expenditure on maintenance. For this reason it was decided to use brass or bronze on an unprecedentedly large scale. These alloys were adopted for valve bodies, junction pieces, gate chambers and the like, in castings up to 10 tons in weight. Anchor bolts, ladders, valve stems, and all other important elements subject to corrosion and requiring to be of considerable strength were made of the same metals forged, drawn, or extruded. In all some 2,000,000 lb. of these alloys were used for castings and another 1,000,000 lb. weight in the shape of forged, rolled, drawn or extruded metal. These wrought metal components ranged from small bolts up to sluice-gate stems, 6 in. in diameter and 31 ft. long. The alloys mostly used were manganese bronze, naval brass and Tobin metal.

On the whole the castings are said to have so far proved satisfactory, particularly in the larger sizes, though there has been trouble in certain cases, in which faulty castings have been repaired by burning-in. The contraction strains set up in this process led to a certain number of spontaneous fractures, until remedied by an insistence on a thorough after-annealing of the casting. There was also little trouble with the heavy forgings, but wholly unexpected troubles arose with the smaller articles, such as bolts, ladder rungs, and pipes. This was the more disconcerting as the manufacturers were amongst the most experienced in America, and were given a very free hand as to their methods of production, and were undoubtedly under the belief that they could produce wrought brasses and bronze equal in strength to steel, non-corrodible and capable of withstanding all workshop manipulations without injury.

The specifications had been prepared with great care after a study of all the technical literature available. The test requirements were as follow :—

Material.	Ultimate Strength.	Yield-Point	Elongation.
	lb. per sq. in.	lb. per sq. in.	p.c.
Bronze castings	65,000	32,000	25
Rolled material (thin) ..	72,000	36,000	28
Rolled material (above 1 in. thick)	70,000	35,000	28
Rivet brass..	55,000	30,000	20

Actually these requirements were considerably exceeded. The forgings showed an average ultimate strength of 74,000 lb. per sq. in., a yield-point of 43,000 lb. per sq. in. and an elongation of 35 per cent., and the castings had an average ultimate strength of 69,000 lb., an average yield-point of 40,000 lb. per sq. in., and an average elongation of 35 per cent.

That much of the lighter wrought material was unreliable was discovered in 1913, when inspection led to the detection of many cracked bolts, and a thorough investigation ensued. This showed that bolts, rods, ladder rungs and the like had in many cases fractured whilst still in store. The bolts involved ranged from ½ in. up to 2½ in. in diameter. In some cases the cracks extended over almost the whole cross-section, whilst in others they were little developed. A laboratory investigation showed (as was previously known) that heavy initial stresses existed in the cold-worked material, and the suggestion is made that these stresses are raised beyond the ultimate strength of the material by temperature changes or by comparatively light loadings. Nevertheless it is very remarkable that ductile material should be incapable of relieving itself of excessive stresses by taking a permanent set. Mild steel is certainly capable of acting in this way, though of course there are sporadic cases in which spontaneous failures have occurred, even with this material. It is noteworthy that specimens cut from the cracked brass rods showed excellent ductility, even when taken from the immediate neighbourhood of the cracks.

An attempt was made to discriminate between the reliable and the dangerous material by means of Martens' and Heyn's plan of treating the surface with a solution of a mercury salt. In some cases this caused cracks to develop almost instantaneously, but in other cases not till after the lapse of some days. It was, in fact, found to be far from infallible, as rods which withstood the test for a considerable time afterwards failed, and in any case the test takes too long to apply to be of practical value.

It was subsequently decided to use nothing but extruded metal or hot-rolled material wherever possible, and to insist on the thorough annealing of all cold wrought material. In this way it was hoped that further trouble would be avoided, but the expectation was falsified by the event, as failures continued to a disturbingly great degree. Further experiments indicated that corrosion had much to do with the cracking. To test this a number of bolts, 1 in. in diameter and 6 in. long, were put under a tension sufficient to produce a permanent set, and then exposed to the action of ammonia. After two days all the bolts, whether of manganese bronze, naval brass or muntz metal, whether drawn or extruded, were found to be seriously attacked; the cracks extended in some instances over 80 per cent. or 90 per cent. of the cross-section. Check experiments, in which the bolts were left under strain but not exposed to corrosion, or exposed to corrosion without being under strain, showed that in these cases the metal was uninjured. A further experiment indicated that red lead might act as a corroding agent to bronze and brasses under stress. Mr. Jonson maintains as the result of this investigation that the ultimate strength of brass or bronze liable to corrosion does not exceed 20,000 lb. per sq. in. An exceedingly singular result was observed in further experiments, in which corroded rods were tested in bending. Such rods tested without being cleaned could not be bent through an angle of more than 45 deg. to 80 deg. without fracture, whilst if cleaned up with emery cloth they could, it is stated, be bent without breaking through an angle of 160 deg. to 180 deg.

In general the experience on the Catskill aqueduct has led to the conclusion that none of the bronzes used could give the same duty as steel, and that no make of brass or bronze was exempt from failure save, so far, in the larger sizes of castings and forgings. Possibly in the case of the forgings we have an effect converse to the difficulty experienced with heavy steel forgings. Here the difficulty was to ensure that the effect of the surface working should extend to the centre. Possibly in the case of the brass alloys it may be an advantage if it does not do so.

The heavy castings have, as stated, proved satisfactory so far, and in view of the very large quantity used a special value attaches to the recommendations made by Mr. Jonson in connection with the design of such castings. He states that oxidation in the crucible is a very common defect, especially with mixtures containing much copper. To ensure against this defect the metal must be tested. Included dross is, he says, very difficult to detect, save hydraulically, and even this test is uncertain, as the honeycombed portion may be overlaid with sound metal. The remedy is good moulding, but the fault for bad does not, he says, always lie with the foundry-man, but with the designer. Every bronze or brass casting should be designed with reference to a given position in the mould, and the various parts should be arranged so that they are connected by a rising channel of increasing cross-section and with a minimum of offsets, with one of the risers, which should be of much larger diameter than the thickest part of the casting. Where practicable the castings should be poured from the bottom. When a flange forms the upper surface of a casting some dross may be expected there, and adequate allowance should be made for machining it off. A common fault is, he says, an insufficiency of risers, and as foundry-men, for the sake of economy, incline towards reducing these to a minimum, it is well to specify on the drawing the total cross-section of the risers as a percentage of the greatest horizontal cross-section of the casting.

As bronze castings are expensive they should not be rejected for remediable defects. Minor leaks may be stopped by peening, but such leaks frequently indicate defective metal. The common belief that brass and bronze mixtures are necessarily porous is, Mr. Jonson says, erroneous, as sound metal will not pass water, even under 1,000 lb. pressure. Hence, if water comes through under an hydraulic test, even in very minute quantities, it shows that the metal is porous or not clean. An hydraulic test under 100 lb. per sq. in. will generally reveal the defect. Small defects may be made good by drilling the casting and screwing in a plug. Where this cannot be done, the bad metal must be cut away, and the cavity made good by burning-in or by melting in fresh metal by a gas flame.

* "Brass in Engineering Construction," by Alfred D. Flinn, Proceedings of the Municipal Engineers of New York, November, 1914. "Inspection of Brass and Bronze," by Alfred D. Flinn and Ernst Jonson, American Society for Testing Materials, annual meeting, June, 1917. "Cracking of Drawn Brass," *Engineering Record*, April 11, 1914, by Ernst Jonson. "Fatigue of Copper Alloys," American Society for Testing Materials, 1915, by Ernst Jonson. "Notes on the Inspection of Bronze and Brass," American Institute of Metals, 1916, by Ernst Jonson.

THE REPORTS ON INDUSTRIAL UNREST.

A careful reading of the reports of the eight Commissions appointed to inquire into Industrial Unrest confirms the views that we expressed on the official summary. The reference to the Commissions was in the broadest terms, and by almost

all of them has been so interpreted. As a result the Commissions have had to face a task that could not be done in the time allowed. Each of them was required to make a thorough investigation of a most complex subject, and in the endeavour to do so had to deal with from 100 to 200 witnesses orally, besides perusing a large number of written communications. They had further to make their own arrangements for attracting the necessary evidence, and for their meetings, often in a number of different centres, to consider their conclusions, and to draft and settle their reports. They were appointed on June 12; the earliest report, that of the Commissioners for the North-Western Area, who first met to hear evidence on June 21, was signed on July 9, and the latest on July 12. A supplemental inquiry on the Barrow-in-Furness district by the North-Western Commissioners was begun on July 10, and the report was signed on July 16. It is needless to labour the extent of ground that had to be covered, but in illustration of it the report on Wales may be quoted; this ends with a summary of principal recommendations running into 49 clauses. A number of the reports mention only that they have dealt with the "views" submitted to them by witnesses, and thus admit in effect that they have had to take their facts at second-hand. More than one professes only to reflect the views so collected, without either adopting or correcting them; and in at least one it is admitted frankly that no opinion could be formed without the attendance of many witnesses who were not available in the time at disposal.

For meeting an emergency in which the lives of an army now numbered by millions are at stake this procedure may possibly be justified; but it would be trifling with our readers to ask their attention to the reports as embodying what in any sense can have been a thorough inquiry into the factors of industrial unrest, or a fundamental basis for action directed to the situation after the war. The Commissioners as a whole have not only shown an untiring anxiety to do their utmost, but many of them have emphasised and illuminated much in the situation that ought to be brought into relief. Their reports may be studied with interest as a reflection of the varying opinions that they had the opportunity of hearing, with which it is obvious that some of them were familiar in advance. But they cannot be considered seriously as a resolution of the conflicting opinions that have to be reconciled as to future needs, or a verdict on facts; not that the Commissioners would have been unable or unwilling to collect the facts and find such a solution or verdict if time had allowed, but that to do so in the time at their disposal would have been impossible for any body of men. The situation is perhaps best illustrated in the excellent report of the Commissioners for Scotland, who say plainly that they have tried merely to reflect the opinions that have been put before them, without necessarily adopting what was represented; and, in contrast with most other Commissioners, they practically confine themselves to questions affecting the conduct of the war, on which they offer valuable and informing recommendations.

That, indeed, is the subject on which engineers and the country need immediate action by the Government; and such evidence as is furnished by the reports only confirms what was known before to engineers and has been emphasised repeatedly in these columns. In what concerns engineers perhaps the most important of these considerations are those that relate to the dilution of labour and the operation of the Military Service Act. As is remarked by the Commissioners for the London and South-Eastern Area, the difficulties that have arisen in dilution have been largely due to the fact that they have been conducted "haphazard" and not "on any well-defined principle." We have pointed out repeatedly how impracticable the present procedure is, and it is to be hoped that at last the Government will proceed to make the systematic and uniform use of its woman-power that has not been made up to now. At bottom the difficulty in doing so lies (and is so exhibited in a number of these reports) in part in the anomalous application of the Military Service Act, and in part in the intrusion of bureaucratic methods into what is really a matter of engineering works management. The statement of the Government early in the war that at that time engineers could serve the country better in the shops than in the line has been construed as a pledge that engineers should not at any time be taken for the Army. It is not surprising to find from the reports that, while the unions of the numerous protected trades are pressing for the exemption of their members as of right, the unions of other trades resent and dispute the justice of the privilege that is claimed. By what mandate a democratic Government could have been imagined able to distinguish between men when all fit citizens of military age were called to the military forces, and to exempt any man whose services in civil life could be performed by women or men of non-military age, does not seem to have been asked; and the absence of a plain statement from the Government that they had no such right and have given no such privilege keeps the unions still persisting in their claims, and the progress of the war still impeded.

The outstanding fact, indeed, that emerges from the consideration of these reports is that the Government does not yet realise that by the side of the interests of the men at the front other considerations are for the time being negligible, and would be recognised as such by all workmen if the Government by its acts and statements made the facts clear to them. Its present attitude is reflected in the advice of the North-Eastern Commissioners in the event of the abolition of leaving certificates. It should, they say, be indicated to the trade unions that their men must only leave gradually, so that they may not "upset existing arrangements or seriously diminish the output of munitions or ships." If what the Government had said of the situation in regard to munitions and ships is true—as there is no reason to doubt—there is no diminution in their output which can be otherwise than serious, nor can any right be honourably or safely granted to men to do anything that would diminish it by a gun or a ship. All that can be done to remedy the food situation, the grave housing scandal that exists in many parts, the insufficient payment of skilled men who, by reason of their skill, are now on day-work, should be done forthwith, as practically all the Commissions recommend. Whatever arrangements are possible for expediting the remedying of hardships, when they arise, should equally be made; and it is satisfactory to find that the Commissions are mostly of one mind in thinking that it is readily practicable to meet this irritating grievance, where it exists. All that is possible should be done to secure men the reversion of jobs from which they may be displaced. Most of these reforms would expedite output, and none would impede it. But the proposals that compromise either on the output of munitions or the maintenance of essential industries, that restrict the employment of fit men in the army for any reason except the impossibility of replacing them in indispensable work, or that seek to bind industry after the war on the strength of a summary and imperfect inquiry, are inconsistent with the present discharge by engineers of their duty to the country and the future safety of their great and complex industry.

THE WASTE AND CONTROL OF NATURAL GAS.

WHERE oil-well drilling is carried on extensively, as in the United States, a considerable loss of petroleum and natural gas is unavoidable. In early days the necessary technology and mechanical equipment that would have prevented much of the loss were both wanting, and waste came to be regarded as the consequence of abundance, or treated in the light of a necessary impost on the operations. In later years of the industry there was less excuse for uneconomical exploitation, but instead of improvement, in some fields of the mid-continent, where production was largest, the abuse grew to such an extent that the Government in the common interest was compelled to interfere. Accordingly, under the auspices of the Bureau of Mines, a commission of inquiry was appointed to examine the technical conditions that were responsible for practices that led to such deplorable waste. Experts have collected much evidence, and from time to time the Bureau has published reports that have attracted considerable attention, as well as not a little dissenting criticism from interested parties. Recently, armed with greater experience and wider information, a fuller report* has been issued that sets out very plainly both the dangers with which the industry is threatened and the appropriate measures for preventing waste and conserving the gas. Though this report may appeal more forcibly to some of our Colonies than to ourselves, for in this country we have not been favoured with petroleum wells or subterranean stores of natural gas, yet it is not without much interest, disclosing as it does the extravagant waste that has been permitted, either from negligence or ignorance, suggesting methods of control that will check the wasteful habits engendered by long-continued indifference, and describing a simple means of mechanical prevention, with the theory underlying its application.

This unfortunate disconnection from a great industry makes it difficult for us to appreciate either the magnitude of the forces at work or the extent of the threatened loss. The figures we are going to quote by way of illustration, regarded absolutely, appear immense, relatively to the stores available they may be of little importance. But in any case they express only part of the loss, they refer only to the waste at the surface, that which can be calculated with some approximation; they tell us nothing of other and possibly greater losses underground, due to the gas migrating or dissipating through other geological formations and becoming irrecoverable in commercial quantities. The losses attaching to this latter class can only be inferred, and will come under consideration later; of the former, it is possible by a typical instance, one of many that the authors have reported, to gain some insight into the recklessness that has hitherto prevailed. A gas well in Ohio was allowed to blow into the air for ten years. When at last an attempt was made to bring the well under control the daily escape of gas amounted to 4,500,000 cub. ft. It was not entirely closed in until two years later, and it is safe to say that the total volume of the gas wasted could not have been less than 15,000,000,000 cub. ft., whose fuel value would have been equivalent to 750,000 tons of coal. From the many examples displaying similar or even more extravagant features one is prepared to admit, simply as a matter of figures that the imagination is incapable of realising, the approximate accuracy of the estimate that up to the end of 1912 the waste of gas in the mid-continent fields alone did not fall short of 425,000,000,000 cub. ft., possessing in the aggregate a heating value equal to 21,250,000 tons of coal. It is only the conspicuous instances that come under notice, the accumulated waste from innumerable smaller wells must be enormous, and it is probably no exaggeration to say that not half of the natural gas so far developed has been utilised. The pecuniary loss is by no means the only or the most dreaded form that escape of gas can assume. There is ever a great hazard from fire risk, and a large number of deaths and serious accidents from burning gas have occurred during drilling operations. It is difficult for anyone who has not seen it to realise the uprush of flame that characterises a gas fire. The danger of extensive conflagration is so fully recognised that stringent precautions are adopted. No fires, open lights, or automobiles are allowed among the wells, but gas in dangerous quantities may travel many hundred yards from its source, causing much damage and loss of life if ignition should result.

But when the object is to reach oil, everything that delays the accomplishment of that object is an unwelcome hindrance, whether it be gas or other obstacle, and is regarded as a nuisance. That eagerness to reach the goal explains the indifference usually shown to the escape of gas on the oilfields. The gas generally found above the oil sands is regarded as an inevitable evil, to be got rid of with as little delay as possible, and little heed is paid to the fact that where much gas overlies the oil the usual dry-well methods of drilling become a positive source of danger. If there is no ready market for the gas it is allowed to "blow" into the

* "The Use of Mud-Laden Fluid in Oil and Gas Wells." By James O. Lewis and William F. McMurray. Washington: Government Printing Office, 1916. Issued gratis.

air unrestrainedly, generally with the view of reducing the volume and pressure, so that drilling may be conducted with less effort in later wells. Such reduction of pressure may be attended by disastrous consequences, since the lowered pressure may prove insufficient to resist a subsequent introduction of salt water, causing very serious injury to the whole field.

The dangerous risks taken in exploitation warrant Government interference, and as a consequence stringent protective measures have been enforced. But it was first necessary to devise a scheme that should be efficient and economical without being oppressive to the oil industry. Fortunately a practical scheme promising success was ready for application. Experience gained in the oilfields of Texas and California, where the rotary drilling system is in use, suggested the employment of a mud-laden fluid to fill the interstices behind the casing, thus furnishing at small cost an effective lining that would drive water, or oil, or gas, back from the hole, sealing off each stratum, so that the contents can neither enter the hole nor move from one formation to another. Inspectors appointed to supervise the oil and gas-mining operations in Oklahoma, where gas losses amounted to a scandal, have reported very favourably on the adequacy of the method and have recommended its compulsory adoption.

A mud-laden fluid in this sense implies a mixture of water with any clay material that will remain suspended in the water for a considerable time. Sand, limestone fragments, and the coarse materials that result from drilling are not suitable. The consistency is a matter of some importance, to be decided by the special requirements of each case. If used too thin, the fluid will act like clear water and fail to clog effectually the pores of the sand, as intended. In such a liquid condition the mixture may be forced into the sand for some distance and injure adjacent wells, or it may cause "caving," or possess insufficient weight to overcome high-pressure gas. On the other hand, the upper limit of density is the maintenance of a fluid consistency and the possibility of being worked freely through pumps. The method has been submitted to the severe criticism that is incident to the use of all new and unfamiliar devices, a criticism possibly the more severe and the more prejudiced as the simplicity of the plan is evident. It has been urged by interested objectors that drilling could not be conducted in mud-fluid; that drillings could not be bailed from a hole filled with such fluid; that mud would cause the tools and the casings to stick, and, finally, the real objection probably, that its use would cause trouble in drilling and entail additional expense. All these objections, and some others, are considered by the authors on technical grounds and shown to be illusory. Where failure has resulted it has been the consequence of following injudicious practices and the neglect of adequate preparation in advance. Into details we do not propose to follow the authors, but the general principle founded upon the action of colloidal masses is interesting, and may find other uses than the sealing of gas-wells.

The restraining action of a narrow column of mud-fluid on the porous formation with which it is brought into contact may be easily traced. In the particular instance to be considered, that of a drill hole to be cased, the hole must be of sufficient diameter to allow the couplings to pass freely up and down. This implies a vacant space of about an inch between the casing and the walls of the hole, as shown in Figs. 1 and 2, contrasting a finished section with one of incomplete form, permitting possible leakage between successive formations. This danger is so evident that it does not need to be emphasised. The waste of gas passing directly to the surface and making its presence known has already been mentioned, but the loss arising from lateral expansion on the passage from one stratum to another is necessarily undetermined and escapes detection. Not only is the gas lost as an immediate marketable commodity, but by escaping into other porous strata the pressure and volume may be so reduced as to rob it of all commercial value. So accustomed is the driller to this gas waste, and so convinced has he grown of the futility of any practical steps to prevent gas movement, that he objects to incur any expense in what he regards as the impossible task of holding it underground in a form that will render it available for future markets. The object of the mud lining, however, which in favourable cases can be applied at a cost of no more than 30 dols., is to confine the oil and gas to the strata in which they are respectively encountered.

The way in which the clay particles operate to effect this end can be understood by comparison with the action of a filter paper, where in use most of the sediment to be retained is deposited on the surface of the paper, but some enters, diminishing in quantity with the distance penetrated and the nature of the paper. Similarly, much of the mud in the mixed fluid is deposited on the walls of the well and penetrates a distance into the formation depending on the combined pressure produced by the column of the fluid and the pump, the porosity

Fig. 1. GENERALIZED SECTION OF COMBINATION WELL FINISHED WITH MUD-LADEN FLUID.

Fig. 2. GENERALIZED SECTION OF UNCASED HOLE, PERMITTING COMMUNICATION BETWEEN FORMATIONS.

of the formation, and the consistency of the fluid. Herein is seen the vital importance of a correct consistency of the fluid, to which allusion has been made. Though a variation between fairly wide limits is permissible, there can be no doubt but that many failures can be traced to the use of a fluid of improper consistency or of unsuitable materials. This is the more probable in the Cushing field of Oklahoma, where the formations contain much sand and but little clay. It is, however, generally admitted that except in the case of some fissured formations, or where unusually coarse sand is encountered, the mud-laden fluid will form a plug that is impervious alike to oil, gas or water.

Two points in this connection are worthy considering—Why does not the clay settle, reducing the upper portion of the column, at least, to a very thin fluid unsuitable for sealing the pores; and, secondly, why does not the pressure of the gas force out the thin barrier created by the mud deposit? To those who have seen and suffered from conflagrations and explosions, the means employed seem too slight and inadequate to achieve its aim. The very simplicity of the proposal suggests to some a ground for mistrusting the thoroughness of the expedient. Whatever suspicion may be entertained, however, is not warranted. It is a peculiarity of colloidal materials to remain in suspense for an indefinite length of time. Experiments on columns of fluid in short tubes show that for some hours settling is fairly rapid, but after a few days a condition of equilibrium is established, and that no more settling takes place, however long the mixture is kept under observation. In a long column, such as occurs in actual practice, the settling operation must occupy a very long time, and no instance has yet been found in which mud-fluid has solidified behind the casing of deep wells. If settling does take place, and there is reason to suspect too thin a composition near the top of the column, where there may be formations it is desirable to protect, more or thicker mud fluid can be inserted after an interval. But as a rule the rapidity of the action is as remarkable as its completeness. The authors give many examples of successful treatment of wells that have either been abandoned as intractable or presented unusual difficulties in drilling. As an instance we may quote the case of an Oklahoma well that had been drilled to gas sand at 1,700 ft., when further drilling was prevented by the uprush of gas having a rock pressure of 810 lb. to the square inch and a presumed volume of 40,000,000 cub. ft. a day. As this pressure and volume prevented the lowering of the drilling tools, the Bureau took charge and commenced operations on September 5. Though the necessary mechanism had to be set up for introducing the mud fluid, the well was under control next day and drilling resumed. On September 7 the hole was through the gas sand, and on September 9 the fluid could be bailed from the well and the gas allowed to clean out the hole. Further operations were comparatively simple and gave no further trouble. In other cases of violent outbursts of gas or water the well has been brought under control within twenty or thirty minutes from the time the mud-laden fluid was started into the well. And, further, when drilling other wells on adjacent ground, a year or more later, the formations have been found efficiently protected. Occasionally it will happen that unusual difficulties supervene. A formation may be encountered so porous in its nature, or so coarse-grained, that the thickest liquid possible to work fails to effect an impervious seal. Then it may be necessary to employ thickening substances, as sawdust or chopped ropes, &c., which will pack in the pores of the sand and assist in holding the mud. The remedies to be adopted in such untoward circumstances will be suggested by the experience and ingenuity of the engineer, and in no way affect the general principles involved in the use of the mud lining.

The second point is easily answered. No oil or gas can pass through the mud sealing unless the pressure within the strata is sufficient to force the mud out of the pores and overcome the water pressure in the hole. The resistance to movement of the mud contributes to stability, but the plug is held in its place mainly by the excess of pressure produced by the column of fluid in the hole. Arguing on that ground, some drillers have contended that clear water should have sufficient restraining power, but this is a misconception. The clear water escapes into the sand indefinitely, and a column of sufficient length cannot be maintained to supply the necessary pressure to hold back the gas. But just as clay may require reinforcing by some more clogging material, it will occasionally happen that the gas pressure will exceed that of a column of water extending to the top of the hole. When that occurs the fluid is blown out and the well goes "wild." The remedy is more pressure; this can be supplied by the pump, and if great enough the mud-laden fluid can be forced into the sand. Neither has the mud of itself sufficient adhesive power to hold back the gas. If the column of fluid is removed the pressure within the sand will generally force out the mud coating. Both the clay and the column of fluid are needed, but given such a support the contents of each formation through which the drill passes will be confined to its own stratum and there will follow no movement of oil, water or gas, either from the sands into the well or from one sand into another. "Waste and intermingling are prevented, corrosive waters cannot reach and attack the casing, and the strata are

entirely sealed off from each other as they were before the well was drilled." Where sands of many different kinds are encountered and the passage from water sands to those of gas and oil is frequent, the only feasible plan of protecting the valuable minor deposits is apparently by some such method as that described. The insertion of sufficient strings of casing to protect each deposit is impracticable.

The method of preparing the mud-laden fluid in a convenient and economical manner will be governed by the conditions, geological and mechanical, that obtain in the neighbourhood of the well. The authors, urging practical plans on reluctant or prejudiced drillers, treat such points at considerable length, but they are essentially local in their importance. In combating dilatoriness and urging compliance with legislative measures, it is necessary to show that, far from being an inconvenience, the mud-fluid may be of assistance in many operations. Accordingly they show how the fluid mixture can best be introduced into the well not only when the gas is under fairly normal conditions and can be shut in, but when the quantities of water and of gas are so great as to call for special treatment. The modifications of drilling which may be necessary in the presence of the mud-fluid, the most suitable method for finishing the casing of wells, together with the arrangement of fittings, are of profound interest to those who supervise oil and gas-mining operations, but are rather far removed from the present subject.

A RECORD OF SUCCESS IN MUNICIPAL TRAMWAYS.

No municipal undertaking in this country has been more successful than the Glasgow Corporation Tramways, but the conditions are highly conducive to prosperity. There are no tube railways, and the suburban lines of the various companies are not operated electrically. Moreover, the street paving is not suitable for motor omnibuses; in any case the Corporation, being the road authority, has prohibited the working of these. The cab traffic, too, particularly the motor-cab traffic, is limited, partly owing to the rate being 1*s.* per mile, although no extras are charged. Owing to this and the convenience of the routes of the tramways, the Glasgow people have not acquired the taxi-cab habit to any great extent. There is this further advantage in favour of the tramways, that they traverse nearly all the main thoroughfares, and a passenger in the city area need not walk more than 100 or 200 yards to get a car. Again, the tramways extend a considerable distance beyond the city, the mileage within the city being 149½ miles of single; track and without the city 48½ miles of single track; practically all the lines are double track. Except for the two steam underground railways, the tramways have no competition over a very large area. It must be admitted, however, that, apart from this, the fares and the service are commendable. The only criticism that might be made by the travelling public—and this applies equally to the London and other systems—is that the service of cars is not on all routes in proportion to the density of the traffic, and there are, in some few cases, somewhat long and variable intervals between the cars.

The accounts, which have just been issued, show that the financial situation is most favourable. The total borrowing powers are just over 4,500,000*l.* sterling, but the capital actually expended is about 720,000*l.* sterling less than this. To the amount accumulated in the sinking fund by annual contributions there has this year been added, as a transfer from the depreciation and permanent way renewal fund account, over 2,328,000*l.* sterling, and by this means the capital expenditure has practically been wiped out. This result is in large measure due to the favourable terms on which money has been borrowed on the security of the rates. Thus, only 78,846*l.* has had to be paid in interest during the past year. As compensation for this advantage there has been paid to the "common good fund" since 1894, when the Corporation took over the tramways, a sum of 804,913*l.* Of this sum as much as 160,984*l.* was contributed during the past working year. This "common good fund" is, we might say, the petty expenses purse of the City of Glasgow, being the accumulation of profits derived from various undertakings. The density of the traffic is high. The number of journeys per unit of public served is 337.65 per annum (nearly one per day), and the total revenue now exceeds 1,250,000*l.* sterling, while the working expenditure, including contributions to workmen at the front, is 838,065*l.*, and the net balance, after paying interest on capital and contribution to the sinking fund, is 160,984*l.*, which passed to the "common good fund." The working expenses, it should be said, include the necessary repairs to track and rolling-stock, and the rate of depreciation and permanent way renewal provided for is 200*l.* per mile of single track, and 3 per cent. on power station and sub-station, plant, cars, and the electric equipment of cars; while for other rolling-stock it is 15 per cent., and 5 per cent. for the tramway bridge over the canal at Dalmuir, necessary for the extensive traffic from Glasgow to Loch Lomond, where the city recently purchased a large estate for a public park.

The cars are much smaller than those used in London, and the car-mileage for the past year is over 25,786,000, each car running an average of 104.74 miles per day at an average speed of 8.18 miles per hour. The average total revenue per car-mile is 11.728*d.* The traffic revenue is 7*s.* 2¾*d.* per car-hour. This is high in view of the size of the cars. The traffic revenue per mile of single track operated is 6,282*l.* per annum, or per route-mile 12,540*l.* per annum, each unit of the public served contributing 21*s.* 8*d.* per annum in traffic revenue. All of these are favourable figures, and are due to the relatively small competitive transport facilities provided.

On the other hand, credit must be given for the relatively economical operating expenses. The working expenses only absorb 55.68 per cent. of the total receipts, excluding interest on capital, sinking fund, property and income tax, and payments to dependents of employees at the war. These bring the total to 87.98 per cent. for all expenses, so that the net profit is 12.02 per cent. of the total receipts. The total working expenses per car mile are 7.799*d.* In other words, the average fare paid per passenger is just over ¾*d.*, and the average working expenses, including power works costs, are under ½d., so that each passenger who enters the car yields on an average a net revenue of about a farthing. As regards the fare, the average per mile is 0.44d. The scale of fares advances in ½*d.* stages to 7*d.*, and, generally speaking, there is now a fairly even rate per mile irrespective of the distances travelled, a halfpenny carrying the passenger 1.15 miles and a penny taking him 2.31 miles, while the sevenpenny rate—the highest—takes the passenger 14.48 miles.

The total cost of electric current (calculated on 46,607,090 kw.-hours) is 0.454*d.* per kw.-hour. Only 8.84 per cent. of the current delivered from the power station is lost, and the coal consumed per kilowatt-hour generated is 2.65 lb. The load factor on the total load is 31.9 per cent.

The general financial condition to-day is that the sinking fund, plus the transfer from the depreciation and permanent way renewal fund, has practically equalled the capital expenditure, and, in addition, there is a general reserve fund of 31,034*l.* and a depreciation and permanent way renewal fund of 181,200*l.* Further, considerable separate funds have been accumulated for third party accidents and employer's liability, so that Glasgow has every reason to be proud of the financial condition of the Corporation tramways.

NOTES.

National Armour Plate Factories.

We learn from *The Iron Age* that the United States have for the present abandoned the intention of establishing a national armour-plate plant, in view of the fact now apparent that the establishment cost would very greatly exceed the 11,000,000 dols. appropriated thereto by Congress. The intention was ostensibly based on dissatisfaction with the prices charged by armour-plate makers; but the latter maintained that the Government authorities greatly underestimated certain heavy incidental expenses. Probably the plan originated less in the idea that prices were too high than in a certain prejudice against all armament firms, which had been worked up by ignorant publicists on both sides of the Atlantic for some years before the outbreak of the war, an agitation which quite possibly received a helping hand from the secret service funds of the German Empire. Even now, however, the less intelligent writers of the school in question have failed to grasp the fact that it was the existence of armament firms which saved the world from German domination. Without the supplies of munitions from America during the earlier months of the war the Allies could not have held out on the West, and without the invaluable aid of private firms who provided the "know how" the extraordinary development of our munitions output would have been impossible. To this development, there is a general consensus of opinion amongst those who know, the existing national arsenals have given little assistance, their action having been largely obstructive; so much so, that certain shell makers, driven almost to despair by the perversity of officials, declared that the only chance of a successful issue to the war lay in the complete destruction by Zeppelins of Woolwich and all its works. Fortunately we had in our private firms strong men who were able to force the hands of officialdom and to compel the cancelling of some of the absurd and costly requirements embodied in the original specifications. Some very interesting stories could be told of these struggles, but few will ever be published. One procedure which was found effective was to boldly ignore an absurd requirement and proceed with the making of the shells in spite of refusals by the inspectors to pass them. A threat to send to the War Office a photograph of a large batch of these perfectly sound shells then led to an immediate withdrawal of the ridiculous regulation, to the great benefit of the country.

Electric Properties of Silicon and Germanium.

When examining silicon from the Yajce works in Dalmatia, in 1913, Dr. E. Baerwind and Professor F. Fischer observed that silicon possessed the highest thermo-electric power known. Strangely enough, however, the silicon from different sources differed, being sometimes strongly electro-positive against copper, and sometimes negative, and by combining the positive and negative varieties they obtained, in fact, a thermocouple having the extraordinarily high thermo-electric force of 1,000 microvolts per degree Centigrade. There is always a little iron and other impurity in silicon; such impurities seemed to diminish the thermo-force, but not to affect its sign, and the only characteristic difference they could find was that the negative variety seemed to contain a little silicon oxide, or a little more than the positive variety. When resuming these researches recently in order to determine the exact percentage of oxygen in silicon, Fischer and Baerwind found, however, that it was impossible to exclude all oxygen when analysing their silicon. Compact silicon, they confirm, was indeed not oxidised when heated to 1,100 deg. C. though it turned iridescent; but finely divided silicon was distinctly oxidisable, and as they had to grind their silicon (before dissolving it) in an agate or silicon mortar, and thus to expose constantly fresh hot surfaces to the oxygen of the air, a slight oxidation was unavoidable. They therefore tried to purify the silicon by crystallisation from different metals. Dissolved in aluminium and crystallised from this solution, the Si was always highly positive, no matter whether originally positive or negative. Crystallised from silver or from tin, in which Si is far less soluble, the Si was always negative. Now aluminium would reduce any oxide in the Si, which the silver and tin would not do; but the Si from Al was not free from Al. The specific gravity of the two varieties was the same, 2.33; heating up to 1,200 deg. C. did not change the sign of the thermo-electric force, though heating in a vacuum electric furnace did, and they finally concluded that oxygen is probably responsible, *i.e.*, pure silicon is thermo-electrically positive, but turns negative by being oxidised. Professor C. Benedicks, of Upsala ("Jahrbuch für Metallographie," 1915, pages 225 to 238; the other researches have appeared in the *Physikalische Zeitschrift* of August 15, 1916, pages 373 to

376, and the *Zeitschrift für Anorganische Chemie*, 97, pages 56 to 73, September 12, 1916), had arrived at a different conclusion. Experimenting with germanium, of which he had only a specimen of 0.46 gramme weight (presented by its discoverer, Clemens Winkler) at his disposal, he observed that germanium showed the highest thermo-electric force next to silicon, which he also studied. The germanium was rapidly cooled; white tin he found thermo-electrically negative (weakly), very slowly cooled grey tin strongly positive. Benedicks therefore ascribed the peculiarity to the rate of cooling, which Fischer and Baerwind do not confirm. The two substances also resemble one another in their pronounced rectifying power, which was investigated both by Benedicks and by Fischer and Baerwind. Here, again, the positive and negative variety of silicon differed as to the direction of the rectification. Now thermo-electric force and rectifying power generally go together, but the nature of the rectification is not quite understood. The peculiar behaviour of silicon may help to elucidate the phenomena.

Coal Analysis.

The ordinary coal analysis is confined to the determinations of moisture, coke, volatile constituents and ashes; the ultimate analysis for carbon, hydrogen, nitrogen and also sulphur is not considered necessary as a rule. It is fully understood that the customary methods of the immediate coal analysis are very imperfect and may lead to discrepancies and litigation. Moisture can be determined by indirect, gasometric and direct methods. The indirect method is frequently carried out by heating 1 gramme or 2 grammes of coal for an hour in a drying oven to from 105 deg. to 110 deg. C., and determining the loss of weight. That method is simple, but hardly scientific; coal absorbs oxygen even at ordinary temperatures, there is quite an appreciable combustion near 100 deg., and at such temperatures other gases are liberated from the coal which should not be entered as moisture. On the other hand the gasometric and direct methods—extracting the moisture in artificial atmospheres by some solvent and decomposing or distilling the aqueous mixture—are laborious and require skilled experimenters. Similar objections have been raised against the methods in use for determining volatile constituents and coke. The main difficulty is to exclude the air during the operations without having recourse to elaborate apparatus. That difficulty seems to have been met by a clever apparatus which Dr. Gröppel described in the *Chemiker Zeitung* of May 19 and 26, 1917. There is nothing very novel about the device, which simply consists of a glass vessel of peculiar shape, in which the operations of drying, coking and combustion are carried out, nor about its combination with apparatus suitable for generating a neutral atmosphere and absorbing the resulting products. But something simple and efficient, admitting of directly checking the weight determinations, seems to have been worked out by Gröppel in the Imperial Institute for Coal Investigation at Mülheim, on the Ruhr. His new glass vessel, which he calls a "duck," may be described as a piece of glass tubing so bent and blown out in the central portion that it consists of a combustion chamber, from which two tubes project upward, one to the right, the other to the left; these parts make up the belly, neck and tail of the duck, and the neck and tail are joined by rubber tubing to the accessory apparatus charged with calcium chloride, &c. To introduce the 1 gramme of powdered coal into the belly the duck is held obliquely and a piece of glazed paper, holding the coal and rolled up to a tube, is pushed down the one projection. The paper is withdrawn again, and the duck is coupled up with an apparatus supplying a current of hydrogen and carbon dioxide on the one side, and with the $CaCl_2$ absorption tube on the other side. After expelling the air in the coal and apparatus by the indifferent gases, the duck is heated in a bath to 105 deg. C. for half an hour; after cooling, air is passed through the apparatus and the duck is detached; its loss of weight should be equal to the gain of weight in the $CaCl_2$ tube. The apparatus is then coupled up again, and the duck heated in a Teklu burner, care being taken to expel any tar settling in the neck; the difference in weight: (duck + dry coal) − (duck + coke) gives the weight of (gas + tar + water generated), so that the coke determination can again be checked directly. In the ash analysis oxygen is passed over the coke, which, heated up, catches fire and continues to burn; to complete the combustion the duck is heated to red glow. By combining the duck with other apparatus, further analyses can be performed; but it can all be set up ready for use by unskilled hands.

LITERATURE.

Jane's All the World's Aircraft, 1917. Edited and Compiled by C. G. Grey. London: Sampson Low, Marston and Co., Limited. [Price 21s. net.]

Like all editors Mr. Grey is to be commiserated upon the restriction imposed, in national interests, on the publication of information which might be of assistance to the enemy, and thus this comprehensive compilation is, although exceedingly interesting, still far from complete, especially in those details, alike as to design and production, which even a lay reader would like to learn about. It is probably useless again to make the protest that much is withheld by the authorities which could quite easily be published without detriment to the interests of the Allies. So soon as the enemy have captured any instrument of war there seems to be little advantage in prohibiting the publication of any information which can be derived from such captured trophies, and which would help to maintain and stimulate that *morale* of the nation which is so essential to a vigorous attitude towards the prosecution of a long-drawn fight. Mr. Grey truthfully points out, in his preface, that a photograph may be, and generally is, misleading on purely technical points, owing to the distortion in the lens, or its "one-eyed" perspective. This applies practically to all war weapons, but particularly so in the case of the aeroplanes, as such things as wing curves and areas of surfaces look quite other than they are in reality. "The aerodynamic properties of an aeroplane are vastly more important than its general lay-out, so that a broken wing which gives the enemy the precise 'wing curve' or fore and aft wing section used on a successful machine, or a damaged tail or rudder, would convey far more technical information than could any photograph of a new and intact machine." He concedes the point that a photograph, if published prematurely, might convey information; but after machines have been captured and drawings elaborated by the enemy from the parts intact, the authorities should readily contribute such information, in order to stimulate thought in the direction of improvement. This, indeed, is the procedure in France, where the French technical journal *L'Aerophile* is enabled to publish sketches and photographs of the German machines captured. From these and other sources much valuable information has been obtained for this year's edition of "Jane's All the World's Aircraft." Similarly with the Zeppelins brought down much information has been obtained. Thus of the enemy aircraft constructed since the outbreak of war there are in this volume useful data.

There are several interesting additions made in this year's volume. One of the new features is the tables of world's records, showing the increasing performance of aeroplanes step by step. The airship section has been entirely separated from the aeroplane section, and has been made more largely historical. The engine section, too, has been greatly extended, and, very properly, there is a complete list of honours conferred on members of the British Flying Service, which in itself is a high tribute to the work done by those in that branch of the service which makes the greatest demands on heroism.

The first section is an aeronautical dictionary, a most useful adjunct to a work which, of necessity, appeals to a large number of enthusiasts without the requisite technical knowledge. There are interesting diagrammatic illustrations of the "Pusher" and the "Tractor" biplanes, and in this connection we should like to have seen also a corresponding diagram of a hydroplane, as laymen have a very hazy notion as to the differences. The section also includes an international glossary of technical terms and a table of records made, but this latter necessarily ends with July, 1914.

The second section, "All the World's Aeroplanes," is prefaced by a comprehensive review of the development and work of aircraft in war, and is accompanied by a series of interesting illustrations, principally taken from aeroplanes. The work of aeroplanes during the war is reviewed, and its influence on naval and land operations, particularly the latter, is clearly established by Captain W. E. De B. Whittaker. Then follows a list of aeroplanes, manufacturers, aerial societies, journals, flying grounds, &c., of each nation, arranged alphabetically, and here the information regarding the German planes is much more complete than is the case with those of other nationalities, owing to the freedom with which the French authorities have allowed details to be published in the French journals. It is interesting to note that there are some 56 British makers of aeroplanes, in addition to a large number of firms engaged in producing parts, in comparison with 43 makers of German planes.

The airship chapter has an introduction by Mr. W. L. Wade, and here, again, there is a review of development and work during the war, the disclosures, as a consequence of the examination of Zeppelins brought down, forming a most interesting feature. Details of the airships of all nations are given, together with other information, regarding aerodromes, &c.

The aero-engine chapter is particularly interesting, although here, again, practically nothing can be said about the developments in Britain and Allied countries. There is a preface by Geoffrey de Holden-Stone, in which he deals with the requirements of the service and with the developments. In this case the engines are arranged alphabetically according to the name by which they are known.

The next section deals with historical aircraft from 1902 to 1916, with historical prefaces on war balloons and parachutes by the Countess of Drogheda, and a brief history of modern aeronautics by the editor, Mr. C. G. Grey. As stated by the editor in his preface, this historical section has been revised and largely extended, "in accordance with the suggestion" we made in reviewing the book last year, and we thank the editor for his courteous reference to Engineering.

The concluding chapter deals with aircraft components and accessories, and refers to quite a number of recent developments in this connection. We notice one or two misprints throughout the book, the most glaring being in this chapter, where, on five separate occasions, certain instruments are reported to be by "Elvery," whereas several of the instruments show by their name-plates that they are by the well-known "Avery" firm, of Birmingham.

Flour Milling: A Theoretical and Practical Handbook of Flour Manufacture for Millers, Millwrights, Flour-Milling Engineers, and others engaged in the Industry. By Peter A. Kozmin, of the Polytechnic Institute, Petrograd. Editor of the *Russian Miller*. Translated by M. Falkner and Theodor Fjelstrup. London: George Routledge and Sons, Limited. [Price 21s. net.]

A special welcome may be extended to the advent of a practical Russian work designed to supply an admitted want in our technical literature, for such instances are of rare occurrence. Moreover, the volume appears at a time when the public mind is greatly exercised about the percentage of ground product that must be treated as flour, and the character and quality of the ingredients by which the bulk can be legally increased. But these are points on which the author can offer no direct information. One must read very much between the lines if he would penetrate trade secrets that depend on individual acuteness, and have been learnt in other schools than that of engineering. M. Kozmin confines himself strictly to the mechanical process of flour milling, one that, notwithstanding the many notable advances made of late and the many triumphs of skill and ingenuity it can boast, has failed to attract a recorder equally capable of describing its methods and of discussing the theory of its machinery with the thoroughness the importance of either demands. Germany, of course, has enriched the literature of the subject by some valuable treatises, but of late years her prolific press has issued no comprehensive work exhibiting

the whole details as a continuous and automatic process. The author is, therefore, fortunate in finding a large subject that needs expansive handling, and has seized his opportunity with vigour and success. His experience is wide: he has travelled much, enabling him to make comparisons between the several methods pursued by various nations, as well in Europe as in America, that are both interesting and valuable. We may say here, though not altogether prepared to follow the author's ruling, that he considers English and European milling plant has suffered from the little attention paid to American development, and he asks whether this disregard of American practice is due to conservatism or patriotism. In either case he asserts that European constructors have deprived themselves of valuable assistance and information by failing to follow the originality and inventiveness of their transatlantic colleagues. Such favourable leaning towards American methods by no means unfits the author for fulfilling his main purpose of producing "a practical and theoretical text-book for operative millers and for milling engineers, who have to construct flour mills and to design flour-milling machinery." Messrs. Falkner and Fjelstrup have translated the book apparently in a most satisfactory manner, and the result of the combination is to furnish English readers with a treatise that will remain a standard work till inevitable onward progress calls for a later exponent of more modern methods.

M. Kozmin does well to preface his book with an historical outline of the manufacture of flour, for the plan of the treatise is to study the milling machinery in the order of its growth towards technical perfection. Progress has been built mainly on experience, though the author insists, and occasionally with great satisfaction, that practice, after long groping in the dark, has not reached the correct solution of some important problems without the assistance of severe mathematical and theoretical investigations. But these are generally refinements which affect the economic efficiency of the machine, but do not concern the generic steps that mark progress. We do not undervalue these excursions into the realm of mathematics, or the attempts that have been made to convert algebraical formulæ into metal. Doubtless it is by following such paths that the improvements of the future will be reached. The aim of such improvements, however, is not to produce a better flour, but to produce it more cheaply, or to reduce the consumption of power. With each improvement the task of the inventor grows more difficult, he has a smaller margin upon which to work. Each mill with modern equipment utilising 1,000 h.p. will make 2,500 barrels of flour per day, and some have succeeded in reducing this moderate expenditure to 6 h.p.-hour per barrel. Such a result may be contrasted with the capacity of the first steam mill erected in England, in 1786. The capacity of the steam engine—a Boulton and Watt—was 50 h.p., one h.p. grinding 63 lb. of wheat per hour, and burning 3½ cwt. of coal in doing it. It is the author's aim to explain how this transformation, so far as it depends upon grinding machinery, has been accomplished.

From the time that man discovered how to render his wild seeds more palatable and easy of digestion by reducing them to powder, he has employed two principles to accomplish his object, impact or friction. Of the value of a blow, prehistoric man had ample opportunity of convincing himself, and probably as the result of his experience the pestle and mortar, hollowed out from rough boulders, represent the oldest known mechanical processes, and one whose original purpose has not yet entirely disappeared. Then some genius tried friction between two stones to effect the same object, and became aware of the greater efficiency of the machine, in whatever terms he may have expressed himself. He solved the problem for many generations. His ingenious successors could only suggest larger and heavier stones, requiring animal power for more convenient working, or rendered available for manual labour by the addition of a long sweep attached to the upper stone. The French buhrstone of to-day conserves the principle of the mechanism, except that the upper stone is driven by a vertical shaft which passes down through the eye of the lower and stationary stone. Water power in connection with undershot wheels marks a great step in advance, telling as it does of the passing of the flour mill from the family control into the hands of the common provider for a larger community. It paved the way after many ages for Fourneyrond and the first turbine. By such gradations, involving mechanical improvements and technical skill, but without introducing any new generic principle, the art of milling continued to advance, but could not attain any great perfection so long as the miller was content to reduce the wheat berry to a suitable fineness by one grinding operation. A limit to improvement was imposed by the fact that dust, broken fragments of bran, and other foreign matter could not be removed from the final product, and a clean white flour, the aim of the modern miller, remained impossible of attainment. Hence was introduced the modern plan of gradual reduction, of substituting a series of operations or "breaks," each completing a definite object. The first consists in laying the berry open, the second break cuts off some of the inside of the berry left exposed by the first break. The next takes off some more; and so the process goes on till nothing but the bran is left in its familiar flattened condition.

This improved form made its appearance about 1840, and henceforward the history of milling becomes one of details. It is the peculiar merit of M. Kozmin's book that he follows these details with great clearness, never allowing the object to become obscured by irrelevant matter. The forms of machinery by which certain results are to be produced will differ among manufacturers, and the methods of application will vary in different countries. This variety makes it necessary to describe several forms and processes for accomplishing the same object, but since these descriptions make effective comparisons possible and give the means for contrasting the relative merits, any sense of weariness from repetition is removed. We can only indicate the subject-matter of each section.

A chapter is devoted to the description of the wheat berry, in whose construction we are not particularly concerned, though its formation suggests the adoption of a cutting rather than a crushing apparatus for the abstraction of the contents, and consequently the desirability of employing knifelike corrugations in the break-rolls. Of more importance is the care taken in the preparation of the grain, preliminary to grinding, the separation of impurities, whether seeds of other plants, or small stones, lumps of earth, &c. A great deal of ingenuity is exhibited in the choice of machinery, the final form embodying the experience of ages. The author's comparison of the merits of various typical forms evidences intimate acquaintance with practical work. The description of the methods of separation according to size and shape of the matter to be eliminated is thorough, and the discussion of the relative advantages of different plans of sifting, such as found in the reel-separator and the flat sifter, settles the point on grounds that cannot be questioned. Where iron fragments occur the magnet proves itself a useful adjunct.

In another chapter various forms of machinery are shown for scouring and polishing grain by removing the husk, "beeswing" and dirt in the groove of the berry. The dry and wet process are both examined impartially. In the former the wheat is cleaned by being brought into sharp contact with a rough surface acting as microscopic knives. This is best effected by the use of iron-plated cylinders having narrow openings. Inside the cylinder are rapidly-revolving paddles that throw the wheat grains against the sides, while a strong current of air is drawn out through the vents, which carries off the particles of dirt, shells, germ-coat and beard, leaving the berry unbroken in a smooth and polished condition. In the wet process the wheat passes into a washing machine provided with a rapidly revolving cylinder, which agitates the wheat as it passes through the water. The impurities are thrown off by the centrifugal force, and the grain is partially dried at the same time. Further drying is effected by dropping the grain through cylinders, having baffles to retard the flow, while dry air is blown upward through the wheat. It is important that the water should not penetrate to the starchy part of the grain, but that the skins should absorb a fairly even amount of water. In drying, the moisture in the outer skins quickly dries and they have a tendency to contract, whereas the seed shells still retain part of the absorbed moisture and resist the contraction, with the result that the outer shells burst. In the arrangement of the machinery there is plenty of room for variety of construction and ingenuity of device.

In the next chapter grinding, properly so-called, comes under review. The choice of apparatus is very large, ranging from simple forms of stone mills to the complicated machinery of the roller mill of to-day. In the former there may be either vertical or horizontal axes of rotation and the stone can be natural, when the desired qualities of hardness, tenacity, porosity and uniformity of structure are present, or these qualities may be supplied by an artificial composition constructed from ground rocks possessing the requisite properties. A metal millstone of hard steel will work satisfactorily, and in this case it is usual to make the grinding surface removable and thin, so that when worn it can be easily and economically replaced. Conservative instincts tend to retain the millstone, though the capacity of such mills, with natural or artificial grinders, does not exceed one or two bushels per effective horse-power. With metal grinding discs the capacity is apparently a little greater, but more details are needed before a rigorous comparison can be made. Another form of machine of widely different character, that still obtains recognition, is the "disintegrator," working on the principle of impact. In this form a great output of power is needed and the design is not economical. Of these the author remarks that they have been considered "only with the view of making an end of them once and for ever, and to warn engineers against losing time in perfecting the designs of machines of the impact type."

Finally we come to the roller mill, the type in which cylindrical surfaces, having parallel axes of rotation, bring the working parts into contact along a line. The contact is external, and the velocities of rotation of the two surfaces usually different. The form, material and character of the rollers are decided by the work they have to do in the various processes of reducing grain to flour. In the first operation the grain is crushed or cut into small particles—middlings and dunst—and these particles need to be graded according to size and quality before being reduced further. At the first "break" only a small amount of flour is made, since the earlier portion will contain some of the dust from the crease of the wheat, and as such impurities cannot be removed by washing and scouring, flour of an inferior colour results, which has to be passed to the lower-grade products. In the early stage the rollers used are corrugated or grooved, and the operation can be compared to the chipping of a chisel. The number of corrugations, their shape, and the disposition of the edges are matters of prime importance. In subsequent reduction the surface of the rollers is smooth, and the process becomes one of trituration, but in each successive step the distance between the working surfaces of the rollers demands great attention, the object being to accommodate this space between the break rolls to the size and hardness of the product. An even and continuous flow is essential, and the machinery has to meet many and minute alterations. Temperature, humidity, and ventilation are important factors affecting the performance of the machinery.

The break process supplies middlings of sizes varying from those of quartz sand grains to practically fine flour, and these particles have to be graded so that each grade contains particles of the same size. This grading is effected by bolting through wire, silk, or metal-gauze sieves, having very accurately spaced meshes. The sifted middlings are again submitted to a series of break rolls having finer grooves, or even polished surfaces, but the cutting action is preserved as long as possible, the object being to make finer middlings of coarser, and not to make flour directly, though as the process is continued the crushing action necessarily becomes more prominent. The construction of these sifting machines is considered at great length, and just as

in the case of the comparison between the reel separator and the flat sieves, preference is given to the plansifter because it utilises a great portion of the working area of the bolting surface. Of the types of plansifter operating by rectilinear reciprocal motion, and machines with gyrating progressive motion, the latter form is preferred. The sorting of the product according to specific gravity, or quality, is an important stage in the milling process. The governing thought had its origin a century ago, when difficulties were first experienced in grinding a hard wheat, in which the dry shells, being reduced to a finer bran than in the ordinary soft French wheats, could not be separated from the meal by a bolting process. In the original plan the product, when running from hopper to hopper, was submitted to aspiration (stosswind), which carried the light branny particles in one direction, while the heavier particles were removed to a less distance. For many years this general principle of purifier prevailed, but though effecting its purpose it filled the mill with flour dust, not only an inconvenience, but a source of danger. It seems a simple step to substitute an exhaust for a blast, but the improvement was many years coming. Gravity and sieve purifiers have followed since, but while the principle of working has remained simple, the same cannot be said for the machinery. The principle of the sieve purifier now in use is to make the stock, while travelling over a sieve, imitate the action of boiling, by impelling a current of air of sufficient force under the sieve. The light particles are lifted from the sieve and carried by the draught upward. Part of that light refuse will be sucked out towards the fan, the rest, consisting of heavier offal, will collect in boxes over the sieve.

The work of a mill does not end with the reduction of the wheat berry to an impalpable flour. There are still other operations connected with the transportation of stock—the bleaching and mixing of flour to ensure uniformity and strength of texture; regulating the quantity of product, &c. In the concluding chapters these matters are severally treated, as well as the grinding of other cereals than wheat. The plans for erecting mills, the calculation of working costs, the selection of motive power for the entire plant, are subjects too large to be discussed adequately at the end of a book, but the information given is sufficient for those who are interested in the subject but do not propose actually to embark on such schemes. A fuller index would have added to the value of the treatise.

BOOKS RECEIVED.

Cotton Spinning. By William Scott Taggart. M.I.Mech.E. Vol. III. Fourth Edition. London: Macmillan and Co., Limited. [Price 10*s.* net.]

Centennial Celebration of the United States Coast and Geodetic Survey, April 5 and 6, 1916. Washington: Government Printing Office.

Annual Report of the Governor of the Panama Canal for the Fiscal Year ended June 30, 1916. Washington: Government Printing Office.

United States Bureau of Mines. Bulletins. No. 108. *Melting Aluminium Chips.* By H. W. Gillett and G. M. James. [Price 10 cents.] No. 134. *The Use of Mud-laden Fluid in Oil and Gas Wells.* By James O. Lewis and William F. McMurray. [Price 15 cents.] Washington: Government Printing Office.

United States Bureau of Mines. Sixth Annual Report by the Director of the Bureau of Mines to the Secretary of the Interior for the Fiscal Year ended June 30, 1916. Washington: Government Printing Office.

Madras Presidency, Public Works Department. Administration Report for the Year 1915–16. Part II.—Irrigation. Madras: Superintendent, Government Press. [Price 4*s.* or 2 rupees 12 annas.]

Rand Water Board, Eleventh Annual Report, for 1916, to the Minister of the Interior, Union of South Africa. Johannesburg: W. R. Horton and Co., Limited, Printers.

New South Wales, Report of the Department of Public Works for the Year ended June 30, 1915. Sydney: William Applegate Gullick, Government Printer. [Price 7*s.* 6*d.*]

New South Wales, Annual Report of the Department of Mines, 1915. Sydney: William Applegate Gullick, Government Printer.

Canada: Department of Mines; Mines Branch. Annual Report on the Mineral Production of Canada during 1915. By John McLeish, B.A., Chief of the Division of Mineral Resources and Statistics. No. 426. *Report on the Building and Ornamental Stones of Canada.* Vol. IV. *Provinces of Manitoba, Saskatchewan and Alberta.* By William A. Parks, B.A. No. 388. Bulletin No. 14. *The Coalfields and Coal Industry of Eastern Canada.* By Francis W. Gray. Ottawa: Government Printing Bureau.

THE PRICE OF CARGO STEAMERS AND SAILING VESSELS.

During the quarter April, May, June, 1917, no less than 95 cargo steamers have changed hands, ranging in deadweight tonnage from 11,000 tons down to 130 tons. It may be assumed that these sales have been without exception a source of very considerable profit to the sellers. The following schedule conveys some idea of the numbers and sizes of the steamers sold:—

Number of Steamers Sold.	Deadweight Tonnage.	Total Tonnage.	Number of Steamers Sold.	Deadweight Tonnage.	Total Tonnage.
1	11,000 and over	11,000	7	2,000 and over	15,990
1	10,000 ,,	10,000	17	1,000 ,,	24,185
2	9,000 ,,	18,900	2	900 ,,	1,800
3	8,000 ,,	24,450	4	800 ,,	3,310
5	7,000 ,,	36,400	2	700 ,,	1,445
10	6,000 ,,	63,250	2	600 ,,	1,320
8	5,000 ,,	42,500	4	500 ,,	2,200
5	4,000 ,,	22,725	*Below*	500 *tons*:—	
5	3,000 ,,	17,640	17	.. ..	4,355
			Total tonnage sold ..		301,470

The rate per ton at which these steamers changed hands varied within the widest limits, from 70*l.* down to a mere 12*l.* 3*s.* The following sales are on record for 50*l.* per ton and over:—

Price.	Name.	Deadweight Tonnage.	Where Launched.	Date.	Price per Ton.
£					£ *s.*
126,000	Edith Cavell	1,800	Dundee ..	1908	70 0
105,000	Marne ..	1,500	Kinghorn ..	1907	70 0
70,000	Pellegrini ..	1,125	Sunderland	1909	62 4
660,000	Lovii ..	11,000	Nagasaki ..	1916	60 0
600,000	Southerner ..	10,000	San Francisco	1917	60 0
14,500	Redstone ..	250	Alloa ..	1916	58 0
11,000	Fulwood ..	212	Lytham ..	1900	51 3
42,000	Aberdale ..	830	Paisley ..	1914	50 12
315,000	Kurohime Maru	6,300	Port Glasgow	1905	50 0
100,000	Evangeline	2,000	Glasgow ..	1912	50 0
12,250	Irishman ..	245	Irvine ..	1899	50 0

By way of contrast with these high prices, very few steamers changed hands below 15*l.* per ton deadweight during the quarter April, May, June, this year, only the following:—

Price.	Name.	Deadweight Tonnage.	Where Launched.	Date.	Price per Ton.
£					£ *s.*
21,500	Carlotta Maria	1,450	Sunderland ..	1881	14 16
95,000	Drumcliffe ..	6,670	,, ..	1905	14 4
80,000	Clivegrove ..	6,000	,, ..	1906	13 6
85,000	Belle of England	6,470	,, ..	1905	13 2
80,000	Ramsay ..	6,400	,, ..	1902	12 10
70,000	Castle Bruce	5,600	Middlesbrough	1901	12 10
87,500	Breconian ..	7,200	Sunderland ..	1906	12 3

Of these steamers the following details are on record:—The Kurohime Maru was built at a cost of 35,000*l.*, and after a varied career of eight years was sold for 30,500*l.*; that is, at a loss of 500*l.*, during the last complete peace year 1913. This year, the third of the war, the steamer changed hands at the price given above, an increase of 284,500*l.* The steamer Edith Cavell, sold this spring at the rate of 70*l.* per ton, was sold last year for only 44*l.* 8*s.* per ton, an increase within twelve months of 25*l.* 12*s.* per ton. The steamer Marne, which changed hands recently for 105,000*l.* (70*l.* per ton) was sold last year for 62,500*l.*, equal to only 41*l.* 13*s.* per ton. The Carlotta Maria, sold this year for 21,500*l.*, changed hands during the first war year for one-third that amount, 7,250*l.*; whilst the Pellegrini increased nearly sixfold in value between 1911, when it was sold for 12,000*l.*, and this year, when the steamer changed hands for 70,000*l.*; that is, 10*l.* 13*s.* 4*d.* per ton, as against 62*l.* 4*s.*

The aggregate amount for which these 95 steamers changed hands was no less than 9,362,050*l.*; as the aggregate tonnage, as given above, was 301,470 tons, the average value per ton was no less than 31*l.* 1*s.* The cargo steamer Kurohime Maru, 6,300 tons deadweight, built at Port Glasgow, 1905, and sold this year for 315,000*l.* (equal to 50*l.* per ton), cost in all 35,000*l.* (equal to 5*l.* 11*s.* per ton).

Taking this 5*l.* 11*s.* per ton cost of construction as a basis, and assuming that the whole of the 95 cargo steamers which have changed hands during the past three months could have been constructed at an average cost of, say, 7*l.* per deadweight ton, the total original capital outlay would have been 2,110,290*l.* for what owners have had this year to pay 9,362,050*l.* The purchasers must recoup the difference out of increased freights. When, therefore, war-time freights are compared with peace-time freights consideration should be given to such capital questions. The increased cost of shipbuilding due to the war, as compared with the cost during the former peace period, is well shown by the following figures:—

Name of Steamer.	Deadweight Tonnage.	When Built.	Place of Construction.	Cost of Construction	Price per Ton.
				£	£ *s.* *d.*
New steamer	450	1916	Newcastle ..	9,000	20 0 0
New steamer	7,250	1916	Middlesbro'	124,000	17 2 0
Fagernes ..	5,050	1916	Osaka ..	55,000	10 17 9
Kurohime Maru	6,300	1905	Port Glasgow	35,000	5 10 1
King ..	7,300	1906	,,	46,000	6 6 3

Of the 95 steamers sold during the last three months, 16 were constructed between the years 1880 and 1890, and 20 between 1890 and 1900; these hoary veterans have therefore been put to good use in their old age; so that every possible vessel has been brought into use. Some of these venerable steamers have earned good prices for their former owners, as the following figures show:—

Name.	Date of Construction	Where Built.	Price per Ton.
			£ *s.*
Suyehira Maru ..	1880	Flensburg ..	15 12
Carlotta Maria ..	1881	Sunderland ..	14 16
Yahiko Maru ..	1883	Middlesbrough ..	23 0
Pomona	1883	Port Glasgow ..	29 12
Lindale	1883	Belfast	18 10
Monarch	1884	,, ...	35 0
Cartsdyke	1885	Sunderland ..	16 19
Invercargill ..	1885	Dunedin	24 0
Banseigan Maru ..	1886	Leith	27 15
Kotohira Maru ..	1887	Glasgow	18 3
Itsukushima Maru ..	1887	Newcastle ..	21 17
Sodium	1887	,, ..	32 7
Nikkai Maru ..	1888	Cambeltown ..	25 0
Yechigo Maru ..	1889	Newcastle ..	21 18
Victoria 2	1889	Sunderland ..	22 4
Susanna	1889	Grangemouth ..	38 3

During the same three months seven sailing vessels have been sold to eager buyers, and good prices obtained by presumably willing sellers. The steamers mentioned above are juvenile compared with some of the sailing vessels which have changed hands. One of them dates from 1868 and another from 1877. The aggregate tonnage is 10,586, and the aggregate turnover of capital 183,500*l.* The following schedule gives details:—

Year of Construction.	Name.	Net Tonnage.	Price.	Rate per Ton.	Previous Sale Price.
			£	£ *s.*	£
1868	Superior ..	1,250	28,000	22 8	4,200
1877	Safor	1,133	17,000	15 0	—
1881	Edith Wolden ..	1,080	35,000	32 6	3,350
1884	Guaytecas ..	1,179	32,500	37 10	4,000
1889	Neotsfield ..	1,820	20,500	11 5	—
1889	Wray Castle ..	1,790	20,000	11 2	15,000
1891	Oweence ..	2,334	30,500	13 1	8,000

Industrial Alcohol.—The Co-operative Reference Library, The Plunkett House, Dublin, has issued a pamphlet by Mr. Robert N. Tweedy entitled "Industrial Alcohol." It runs to 88 pages, and is an urgent demand on the Government for facilities for the production of industrial alcohol. Statistics are given of the production and consumption of industrial alcohol in the various chief countries of the world, and of the possibilities that exist in this country for growing potatoes and beets for its manufacture. The publication is a complete compendium on the subject and is worth study, for if we are to establish a large chemical industry we must provide for an abundant supply of cheap alcohol manufactured under the cheapest and, as far as possible, unhampered conditions.

"The Flying Book; the Aviation World Who's Who."—The first edition of this volume appeared in 1914, but the war prevented it coming out in 1915 and 1916. It is hoped that it may be issued yearly in future, and that the restrictions necessarily imposed by the war may be removed, so that the editor may have a free hand. The first part deals with aeroplanes in war, naval aeronautics, aeroplane design and construction, aero engines, airships, kite balloons and other subjects. Then follows a section on modern aeroplanes dealing briefly with each type, and a similar one on aero engines. Aviation firms—British, French and Italian—are mentioned in alphabetical order, while individuals connected with aviation are arranged in a "Who's Who." A number of miscellaneous items complete the volume, which is published by Longmans, Green and Co., at 3*s.* 6*d.* net.

LOW TEMPERATURE CARBONISING AND SOME PRODUCTS.*

By ROBERT MACLAURIN.

MY early oil-work experience at Stanrigg convinced me that non-coking coals could be successfully carbonised without any external heating, and if a method could be devised of preventing the condensing oils from trickling down into the hot producer zones, coking coals, I considered, might also be dealt with. This hope was largely based on Percy's statement that coals when slowly heated lost their power of cohering. After many elaborate schemes had been drawn out, the present simple method gradually evolved (see C, Fig. 1 below). The scheme was put before Bailie W. B. Smith, convener of the Smokeless Fuel Committee of the Glasgow Corporation, and Mr. Lackie, head of the Electricity Department. After consideration by the Gas and Electricity Committees it was agreed to undertake an experiment jointly. I must here record my indebtedness to Bailie Smith, to the members of both committees, to the Corporation of Glasgow, and to the heads of the Electricity Department and the staff at Port Dundas, for their help and courtesy.

The plant as erected with the compartments A and B (Fig. 1) was intended to be used for two purposes. One of these was for the production of smokeless fuel and illuminating gas, and the other for the production of power-gas—both with oil and ammonia as by-products.

Power-Gas.—For the production of power-gas, air and steam were blown into compartment A, by the passage E, indicated by dotted lines, and the gas passed up through the fuel, carbonising it and distilling off the oils. The heavier oils condensed and ran down to the collar, where they were trapped and overflowed along the pipe G to the seal tank S. Here the heavier oils were left, and the gases ascended through the first scrubber, where they met a very fine spray of water, containing about ½ per cent. of free sulphuric acid; from this they entered the second scrubber, in which they were intended to be treated with a shower of heavy oil, to abstract the lighter oils, though this was never put into use. From this scrubber they were drawn by a Sirocco fan, and passed to burners, where they were burnt under a water-tube boiler. The quantity and quality of power-gas made depended entirely upon the fuel used and the quantity of steam passed. Addition of fresh fuel was not traceable by any change of quality of gas. This was anticipated, for the fresh fuel is supplied on to the top of fuel the temperature of which is probably not above 100 deg. C. A fairly uniform power-gas is therefore easily maintained, and as there is no destruction of the oils, the gas is perfectly free from stringy masses of tar. The length of producer enables the carbon in the fuel to be burned practically completely. With the coals tried, clinkering difficulties hardly appeared, although the steam used was occasionally very low. When working steadily we aimed at a saturation at 70 deg. C.

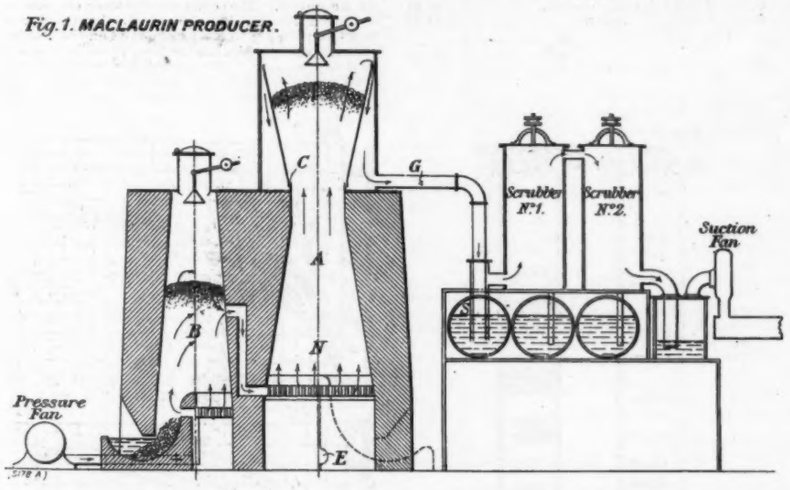
The following is a typical analysis of the power-gas made: CO_2, 12.0 per cent.; O_2, 0.9 per cent.; C_nH_{2n}, 0.2 per cent.; CO, 5.6 per cent.; CH_4, 10.0 per cent.; H_2, 8.9 per cent.; N_2, 61.5 per cent. Calculated heating value = 134 British thermal units per cubic foot.

Smokeless Fuel.—The manufacture of smokeless fuel, contrary to expectation, worked smoothly. The fuel came down regularly and was thoroughly carbonised. No matter the size of the coal used, it was always uniformly coked from outside to centre. Working for smokeless fuel I anticipated getting from 10 cwt. to 12 cwt. per ton of coal, about 10,000 cub. ft. of gas of about 550 British thermal units, from 15 gallons to 25 gallons of oil, and a yield of ammonia at least equal to gas-works practice. The estimate for the coke was made on the assumption that about 2 cwt. of the coal would require to be burned to ash to carbonise 1 ton of coal. To prevent this ash being mixed with the smokeless fuel, the furnace was made with two compartments. The coal was to be carbonised in compartment A, and the hot power-gas was to be made in compartment B, Fig. 1.

In the first trials cannel coals were used and gave no trouble, but the quantity of ash in the fuel was too high for domestic use. A coking coal was next tried, and was used at first just as delivered, *i.e.*, large and small mixed. The downward progress of the fuel was carefully watched—by its effect on the pressure gauges—and before any serious trouble arose we recognised that the quantity of the fine coal was too great, and thereafter the fine was riddled out. Later we found that riddling was only necessary when a large quantity of dross was present. Good screened coal presented no trouble. Only twice in the course of a year's experimenting after this had we any occasion to poke down the fuel—and in both cases the necessity arose from starting with a half-empty producer, and filling up the empty internal hopper too rapidly. The first coke, from Cadder coking coal, unriddled, showed evidence of the fine dust binding the coal into large masses; this we only once experienced. When excessive dross was riddled out the coke retained in the main the shape and size of the coal going in. It is, however, very much harder than the original coal, and some of it is very hard indeed.

Dr. Marie Stopes has examined under the microscope samples of the coke obtained at different levels of the furnace, and has been able to trace the organic structure of the original coal down into the regions where a medium temperature must have existed, then follows a very sharp change in which the original structure disappears. Unfortunately the temperature for each sample examined was not known, but I hope to be able to determine this exactly at a later date. Evidently the coal, under the slow heating to which it is subjected, does not intumesce, and by the time it reaches the hotter regions, where a definite structural change takes place, it has lost the power of doing so.

Fig. 1. MACLAURIN PRODUCER.



Three coals have been coked in the producer so far; these are Tannochside cannel, Cadder coking coal, and Greenhill coking coal. The analysis of the coals and the dried coke is shown in the accompanying table, and for comparison there is shown alongside an analysis of gas-works coke obtained at the high temperature of a horizontal retort. I would specially draw attention to the small quantity of volatile matter left in this coke. In one test it is actually less than in the gas-works coke. I had always assumed that a low-temperature coke contained a considerable percentage of volatile matter, but in the present instances this is far from being the case. The low percentage of volatile matter might lead one to expect that the coke was as difficult to kindle as the ordinary gas-works coke, but trial shows it to be quite easily kindled, certainly quite as readily as coal. Mr. Peter Fyfe, secretary of the Coal Smoke Abatement Society, had a sample tested against ordinary coal, and found that the coke fire kindled more quickly, and attained full redness in 45 minutes, while the coal fire took 1½ hours to attain to an equal redness. The coal fire had to be recharged in 2 hours, while the coke fire did not require to be replenished before 4 hours had elapsed. The temperature in the room with the coke fire was higher by 2 deg. than the temperature of the room with the coal fire.

—	Water.	Volatile Matter.	Carbon.	Ash.
	Per cent.	Per cent.	Per cent.	Per cent.
Cannel coal	10.70	30.72	46.51	12.17
Residue from same ..	—	—	—	18.00
Cadder coking coal ..	10.40	32.97	50.44	6.19
Dried smokeless fuel from same	—	4.77	86.71	8.52
Greenhill coal ..	12.69	33.09	50.63	3.85
Dried smokeless fuel from same	—	3.9	—	—
Coke from horizontal retorts	—	4.30	86.40	9.30

Heat Necessary for Carbonising.—To ascertain how much hot gas would be required to carbonise satisfactorily 1 ton of coal, 13 tons of coal were treated, yielding an average of 13,725 cub. ft. of gas per ton; all the coke coming out during the run, which was of 22 hours' duration, seemed satisfactorily carbonised. Assuming 5,000 cub. ft. of rich gas (700 British thermal units to 800 British thermal units) to be given off from each ton of coal in compartment A, this meant a make of about 9,000 cub. ft. of producer gas in compartment B, and as this gas, presumably, had a value of about 130 British thermal units, the calorific value of the mixed gas should have been 351 British thermal units. The average value found by calorimeter was 180 British thermal units, and by gas analysis on one sample 206 British thermal units. The small quantity, of hot gas necessary to carbonise the fuel was very gratifying, but the low calorific value was both disappointing and inexplicable. According to figures by the late Professor Lewes, with distillation at 400 deg. C. 1 ton of coal would yield the products shown in column 1 below. Column 2 shows what were obtained at Port Dundas. Column 3 shows gas-works results with high-temperature carbonisation:—

—	Carbonising at 200 deg. C.	Port Dundas Method.	Gas-works Practice.
	Cub. ft.	Cub ft.	Cub. ft.
C_nH_{2n}, &c.	315	53	317
CH_4, &c.	3,000	1,420	3,755
H_2	1,060	1,685	4,627
$CO + CO_2$	620	2,973	1,200
N_2	50	6,294	100

In this trial, therefore, we obtained one-sixth of the olefines obtained by low-temperature and high-temperature distillation, and less than half the volume of methane. Unfortunately at this stage accurate measurements of the oil were impossible, owing to the difficulty of separating oil from water, but the percentage of light oil was ascertainable. The following were the figures, supplied me through the kindness of the gas department, for the portion of the oil condensing in the first scrubber: Specific gravity of water-free oil, 1.037. Distilling at 170 deg. C. = 0.34 per cent., specific gravity 0.968; 170 deg. to 270 deg. C. = 21.26 per cent., specific gravity 0.970; 270 deg. to 425 deg. C. = 15.41 per cent., specific gravity 0.995; residue (solid), 62.30 per cent., specific gravity 1.085; loss, 0.69 per cent.

The crude naphtha from low-temperature tars is given by Lewis T. Wright as equal to 9 per cent. on the tar, or 9 lb. per ton of coal. With a high temperature it falls to 3.45 per cent., or about 3½ lb. per ton. In the Port Dundas results it falls to about ½ lb. per ton of coal. In a second test run the gas was no better. The quantity of oil obtained, however, amounted to about 16 gallons per ton of dry coal. This time the distillate up to 170 deg. C. gave 2.6 per cent. of naphtha of specific gravity 0.965. A third test was made in March of last year, using water gas, made by decomposing steam in compartment B, for effecting the carbonisation of the fuel. Naturally, this gave a better gas, owing to the comparative freedom from nitrogen, but the percentage of olefines varied from 0.2 per cent. to 1.1 per cent. and the methane from 7 per cent. to 13 per cent., and the gas was therefore in this respect little better than formerly. To ascertain whether light oils, if produced, could pass the scrubbers, gasolene of specific gravity 0.650 was added both before and after the first scrubber at the rate of ½ gallon per 1,000 cub. ft. The improvement in the gas at the gasometer was not apparent, and analysis showed the olefines and the methane to be practically unchanged. In the first test the olefines amounted to 0.2 per cent., in the second to 1.1 per cent.—practically the same as the preceding two tests, when no gasolene was used. The completeness with which the scrubbers were removing the gasolene might have misled, but fortunately the next test saved an erroneous impression. The scrubbers are centrifugal brush scrubbers, designed for cheapness. Each scrubber is 10 ft. by 4 ft. In order to keep conditions as uniform as possible during the additions of the gasolene, the fuel was not disturbed in either A or B compartment, but as soon as the tests were over ash was removed in compartment B, and an immediate improvement in the composition of the gas followed. The olefines rose to 1.4 per cent., the methane to 15.7 per cent., and the calorific value to 377 British thermal units. This improvement in the gas followed the bringing down of new fuel in B compartment, and the rise in the olefines was undoubtedly due to the hydrocarbons driven on from this fuel being partly decomposed, as they passed up through the hot fuel in compartment A, into ethylene and other light hydrocarbons. The scrubber allowed these light gaseous hydrocarbons to pass, while it prevented the passage of the heavier hydrocarbons of the gasolene.

These results, together with later results and numerous unrecorded results, convinced me that it was hopeless to look for rich gas by a true low-temperature method; though I firmly believe that illuminating gas will yet be made in a plant such as I have described. This, however, will be done by a semi-high temperature method.

At the completion of the third trial, in an endeavour to account for the absence of the light hydrocarbons, the oils were examined more thoroughly. The oil was so hopelessly mixed up with the ammonia liquor that it seemed impossible to get it into a marketable state. Even a sample which to all appearance was water-free showed about 20 per cent. of water on distillation.

In the examination of these oils the Corporation allowed me to have the assistance of Mr. Harris, head of the chemical department, when required. Mr. Harris

* Paper read before the Society of Chemical Industry at Glasgow.

appointed Mr. Cockburn to assist in the investigation, and I have here to thank both gentlemen for their assistance and suggestions. The gas department also carried through analyses and distillations for me, and to them I am also indebted. The fickle character of the oil under distillation appears to be wholly responsible for the fact that a distillation carried out by the chemical department had no resemblance to a distillation of the same oil by the gas department. For instance, when Mr. Cockburn distilled a certain portion of the oil in a glass retort he got a series of fractions of steadily increasing viscosity. When the gas department distilled a larger quantity in a copper still, perfectly liquid oils came over to the end.

Oil.—The oils obtained from cannel coals were distinctly lighter than water, brownish-green in colour, buttery in consistency. The setting-point was about 30 deg. C., they were apparently paraffinoid in character, and resembled the crude oil obtained from shale rather than that from coal tars. The oils from coking coals were decidedly heavier than water, darker in colour, about the consistency of butter, having a setting-point about 20 deg. C., and in general less paraffinoid in character than the oils from cannel. Both oils retain a considerable percentage of water with great tenacity. Typical distillation tests of some of the crude oils obtained are given below, with water deducted.

Oil from Cannel. Specific Gravity about 0.950.	Per cent.
Oil of 0.819 specific gravity ..	13.0
Oil of 0.850 specific gravity ..	13.0
Oil of 0.910 specific gravity ..	32.75
Paraffin scale, m. pt. 119 deg. F. (without freezing)	7.25
Hard pitch	6.75
Loss on washing, &c.	27.25
	100.00

Oil from Coking Coal Distilled from Copper Retort.	Per cent.	Spr. Gr.
Oil to 170 deg. C. ..	3	0.965
170 deg. to 270 deg. C.	12	0.968
270 deg. to 425 deg. C.	16	0.992
Residue	69	1.108
	100	

Coking Coal. Oil Distilled from Iron Retort. Specific Gravity 1.048.	Per cent.
Oil to 170 deg. C.	6.05
170 deg. to 230 deg. C. ..	13.06
230 deg., upwards	45.64
Residue	34.25
	100.00

The high percentage of water made these oils troublesome to distil. The large percentage of pitch from the coking coals at the low prices prevailing and the want of knowledge of the nature and use of the distillates made distillation unpromising. The prospect of using the oil direct for creosoting seemed more hopeful. On testing for phenolic substances, by extracting with caustic soda, 40 per cent. to 50 per cent. of the oil passed into apparent solution. With the high prices prevailing for carbolic and cresylic acids, it seemed unreasonable to offer this oil even at 3*d.* per gallon, the price of creosote oil, and I extracted a portion of the oil with caustic soda, separated the supposed phenols with sulphuric acid, and sent a sample of this to the makers of Lysol, but they reported that it was useless to them.

Low-temperature carbonisation has been repeatedly credited with a heavy yield of cresylic acid, and I considered that in this material there was probably a group of phenols of high boiling-point. Phenol itself was not present in any quantity, since only very occasionally could its presence be traced by its action on the skin. The boiling-point might have been a true indication as to whether the crude oils contained much cresol, but I found that decomposition apparently set in at about 200 deg. C., so I assumed that we had to deal with phenolic bodies in combination with organic bases.

Crude Oil and Resinous Portion.—Distillation appearing unsatisfactory, direct uses were sought for the crude oil. The fact that it dried on wood, leaving a glossy surface when well rubbed in, suggested its use as a furniture polish or as a protective covering for wood. Wood rubbed with crude oil will afterwards take both paint and varnish. This, I am told, is not the case with coal-tar oils, unless specially prepared.

The separated cresylic portion (see Fig. 2), when heated at slightly over 200 deg. C. for a short time, gives off phenolic vapours. Fully two-thirds will not come over at this temperature, but remains behind as a resinous pitch.

At this stage it was found that when the oil was agitated with paraffin in a separator, the mixed liquids divided into three layers, the top being a semi-liquid oil, the middle one water, and the lowest layer a heavy black resinous tar. If weak acid is added to the top oil, and it is again agitated, a second separation takes place, almost exactly similar to the first, only the bottom layer is redder in colour. This I have termed red resin. If the top oil of this second treatment be now treated with caustic soda, a portion passes into solution, and this can be separated with acid. For want of a better name I have termed it the cresylic portion. The neutral oil that remains after washing with water I term Port Dundas lubricating oil. The diagram, Fig. 2, will help to visualise the separation and the approximate quantities.

The resins, when thinned with turpentine, give satisfactory yellow varnish stains; with methylated spirit brown stains, and with benzol, black varnishes.

Distillation of the separated portions of the oil seemed to promise to give useful information, so we had the resin distilled. The result of distillation in a glass retort, obtained by Mr. Harris's department, is given below:—

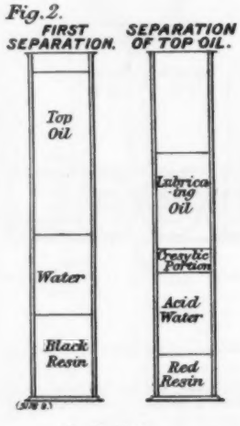
C. D. Resin.

	Per cent.	
Water	3.3	
Oil to 150 deg. C. ...	0.9	Dark brown fluid.
150 deg. to 185 deg. C. ...	1.1	Yellow fluid.
185 deg. to 195 deg. C....	1.3	
195 deg. to 215 deg. C....	18.2	Golden brown. More viscid than above.
215 deg. to 240 deg. C....	2.6	" "
240 deg. to 270 deg. C....	3.5	Brown. Viscid. "
270 deg. to 300 deg. C....	7.5	Brown. Very viscid.
300 deg. to 320 deg. C....	7.1	Dark brown. Thick jelly.
320 deg. to 350 deg. C....	7.1	Dark brown. Solid jelly.
350 deg. to 355 deg. C....	8.8	Almost black. Solid jelly.
	61.4	
Residue	38.6	
	100.0	

The temperature remained fairly constant at 200 deg. C., and decomposition apparently set in at 355 deg. C. The residue was a blackish, very friable pitch. Guaiacol and creosol were found to be absent, as was also abietic acid.

With the object of getting larger quantities of each fraction for refractionation, Mr. Macdonald, at Tradeston Gas Works, distilled a larger quantity in a copper still. The results of this are noted below (Fig. 2).

Fig. 2.



C. D. Resin.

	Per cent.	Specific gravity.
Water	5.9	—
Oil up to 170 deg. C. ...	3.35	0.907
170 deg. to 200 deg. C....	1.55	0.962
200 deg. to 215 deg. C....	4.65	0.974
215 deg. to 240 deg. C....	5.80	0.980
240 deg. to 270 deg. C....	6.00	0.982
270 deg. to 300 deg. C....	8.30	0.986
300 deg. to 325 deg. C....	3.60	0.991
325 deg. to 350 deg. C....	0.20	
350 deg. to 370 deg. C....	0.50	
	39.85	
Pitch	60.15	Specific gravity 1.14; very hard and brittle.
	100.00	

All products were quite fluid, but dark in colour, and had an odour like that of solvent naphtha.

The difference in these results made it appear that distillation would be useless unless under reduced pressure or in a current of steam.

Lubricating Oil.—A distillation of the lubricating portion of the oil, made by Mr. Cockburn, is given below. Up to 170 deg. C. water = 3.4 per cent.; oil = 2.6 per cent.; 170 deg. to 200 deg. C. = 1.0 per cent.; 200 deg. to 270 deg. C. = 16.2; 270 deg. to 360 deg. C. = 34.0 per cent.; 360 deg. to 370 deg. C. = 9.2 per cent.; 370 deg. to 375 deg. C. = 4.4 per cent.; 375 deg. to 310 deg. C. = 5.6 per cent. The small percentage distilling over below 170 deg. C. and the smell indicated the absence of benzene, toluene, &c., and of all the lighter paraffins, olefines, and naphthenes. The respective members of the three groups boiling about 200 deg. C. are dodecane, $C_{12}H_{28}$; dodecene, $C_{12}H_{24}$; and dodecanaphthene, $C_{12}H_{28}$. Towards the end of the distillation crystals formed in the distillate, particularly between 290 deg. and 360 deg. C. These were apparently higher paraffins, but might be olefines or naphthenes. The drop in temperature at 375 deg. C. is particularly noteworthy. Mr. Cockburn remarks that "at this point (*i.e.*, 375 deg. C.) the character of the distillate changed—a reddish oil coming over. The temperature fell steadily till it registered only 310 deg. C. All the time, however, the reddish oil continued coming over, and a strong smell of ammonia was noticed (and detected by litmus). This reddish distillate measured 5.6 per cent. Granular crystals separated on cooling—mostly naphthalene (judging by the picrate test). Decomposition of nitrogen compounds explains the presence of the ammonia."

This oil impressed me from the beginning as having remarkable lubricating qualities, and although Lunge states that oils from blast-furnace tars made only inferior lubricants, I had the Port Dundas oil tested by the kindness of Dr. Gray in the Thurston friction engine. The first tests were very encouraging, and later tests have confirmed the remarkable lubricating power of these oils. I selected the best oils given by Hurst for durability, and compared them with the Port Dundas oil, run under similar conditions. The results are shown on the following diagrams.

Fig. 3 gives the results with castor oil, sperm oil, and a heavy Port Dundas lubricating oil. With the castor oil the friction was so great that the test was not proceeded with. The Port Dundas oil ran for 60 minutes the first day, and 25 minutes the second day. The pure sperm ran for 15 minutes the first day, and 50 minutes the second day. It is remarkable that the Port Dundas oil has always run at a lower temperature the second day, while most of the other oils tried have been slightly higher.

Fig. 4 shows a Scotch mineral oil of specific gravity 0.890 run against a light Port Dundas oil for friction and durability only. This oil was the distillate between 290 deg. and 340 deg. C. of the lubricating portion of the oil. On filtering out the crystals, which were large, flat, waxy crystals, like paraffin, the durability of this oil decreased. The crystals smeared on the bearing improved the results again. All the tests were run at 48 lb. pressure to the square inch on the bearing, and at 2,000 r.p.m. Neither of these two oils indicated any tendency to gum. The remarkable feature in the Port Dundas oil is the high durability shown, combined with the fact that its viscosity is very low; also the

Fig. 3.

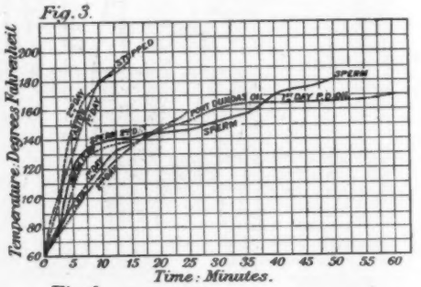
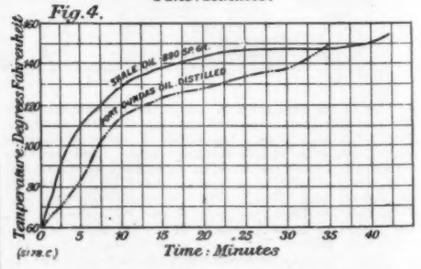


Fig. 4.



complete absence of any tendency to gum in a coal-tar oil which had not been distilled, and from which resinous substances had only been extracted by treatment with soda.

Dye Products.—About this time it was found that water which had been standing over the resin became strongly coloured red on addition of caustic soda. It was therefore of interest to examine the effect of alkalis on the resin; 3½ gallons were agitated with dilute sodium carbonate solution, the red liquor poured off, and the process repeated until 8 gallons of strong red liquor had been obtained. This occupied a week. The liquor after this became browner and muddier, and the extraction was stopped. Evidently if water extracted this colouring matter from the oil, the ammonia liquor which had been so thoroughly mixed with the oil should contain the same material. On adding caustic soda to the slightly acid ammoniacal liquor from the tanks, a bright blue colour was produced at once; a little more soda turned this red. The purple ammoniacal liquor was found to dye wool neutral grey shades. The red liquor does not dye unmordanted wool, but the colour is fixed satisfactorily on a chrome mordant. When the purple colour was oxidised with bleaching powder, a dull yellow was obtained, which also dyed unmordanted wool.

The Port Dundas ammoniacal liquor is apparently free from both ferrocyanides and thiocyanates. The purple grey colouring matter can be obtained in a solid form by evaporation of the neutral liquor. The quantity present is quite considerable, and without any purification whatsoever the ammoniacal liquor produces pleasing purple-grey shades, which are at least faster to

light than those obtained with the ordinary aniline dyes. With the object of separating basic substances from the resin remaining after the soda treatment, it was treated repeatedly with dilute sulphuric acid, air being blown through the solution meanwhile. The solutions were coloured yellow, and on cooling deposited a golden-yellow resin very soluble in dilute acids. At the end of the third day's treatment the quantity of resin remaining amounted to about 4 per cent. of the oil originally used. It was still black, and on further treatment dissolved in the same manner as before.

The dilute yellow solutions thus obtained were found to dye wool, at the boil, without mordant, in shades fairly fast to washing. When the solutions were evaporated a dirty, unprepossessing powder was obtained. This had very little dyeing power. When the resin itself was treated with nitric acid of a certain concentration a decided action ensued, and a yellow liquid was obtained, together with a light, spongy char. The yellow liquid was neutralised with lime, filtered, and evaporated to dryness. Attempts to purify this further resulted in the colour steadily disappearing. A rough calculation indicated that 1 ton of coal would have yielded sufficient resin to give by sulphuric acid treatment sufficient colour to dye 800 lb. of wool, but the yellow liquor obtained from the nitric acid solution would only dye a minute fraction of this. For some time I could not account for the disappearance of the yellow dye, until I found that the "char" from the nitric acid treatment, on addition of caustic soda solution, immediately gave rise to a solution so strongly coloured as to indicate that this char is practically solid yellow dye. On heating, this char softens like a resin. I am unable to give any enlightenment as to the chemical nature of this product. It does not appear to contain nitrogen. By treating with sodium nitrite, chocolate and neutral browns are obtained, and these seem fairly fast to washing and to light. All the shades produced by these products are much faster than picric acid and methyl violet dyeings; the least fast faded to about the same extent as patent blue, which is one of the faster of the triphenylmethane dyes. The dark grey-blues on chrome mordanted wool and some of the neutral browns have only been slightly affected.

The weak acid solution from a cannel coal contains a pale primrose colouring matter. The "cresylic portion" from a cannel contains no cresylic acid, but gives a red-brown precipitate which by treatment with weak nitric acid gives two portions, a resinous scale and an iron-red precipitate. Both portions give with caustic soda raw sienna colouring matters, of considerable purity. These soda-soluble substances would suggest a phenolic or naphtholic origin, but the black resin, after boiling with caustic soda until the soda takes up no further colour and then treating with weak nitric acid, gives an almost similar colouring matter, in great quantity. I calculate now that 1 ton of coal will yield sufficient colour to dye 1,500 lb. of wool.

I must mention, however, that the action of soda on the tars has been most erratic. A percentage equal to the black resins is extracted from the crude oil by caustic soda, while the black resin, precipitated by acid, is only very partially soluble in soda. The portion of this resin distilling over between 170 deg. and 240 deg. C., when treated with weak nitric acid, also gives a yellow resinous colouring matter in large quantity. I have already remarked that the crude oil dries quickly in air, and much more rapidly by the addition of a drier, such as manganese dioxide, in this respect behaving somewhat like a boiled oil. After agitating the oil in a closed separator with caustic soda I have frequently noticed the inrush of air on removing the stopper.

Before leaving the subject of dyes I must express my indebtedness to Mr. Steven and Dr. Gray for their help in the matter.

Ammonia.—The titration of the ammonia liquor does not require the addition of an indicator. In practice the change from a yellow colour to a purple colour indicated the time for the addition of more acid. The liquor was generally kept slightly acid (about 0.5 per cent. free sulphuric acid). If the rate at which the coal was being gasified was known, the time taken to neutralise a carboy of acid of known strength gave a measure of the free ammonia being produced, and this could be told directly by the appearance of the purple colour. My anticipation of 45 lb. per ton was based largely on the results obtained by Beilby in 1883, who found that when coal was exposed for several hours to a gas containing hydrogen at a moderate red heat, from 60 per cent. to 70 per cent. of the nitrogen of the fuel was obtained as ammonia. To keep down the temperature, both Beilby and Mond adopted the expedient of increasing the quantity of steam. Now, steam is costly, and it has to be condensed out, and this involves large plant; I therefore decided to obtain the time of contact with the fuel, at an ammonia-yielding temperature, by ensuring that the fuel would not reach the combustion zone until it had been exposed for many hours to the hot gases at temperatures varying from 450 deg. to 750 deg. C. This only necessitated providing a large storage chamber surrounded by thick non-conducting walls. In Fig. 1 the zone N is the ammonia-producing zone, and as the coal takes approximately 20 hours to be heated from 15 deg. C. to 1,000 deg. C., it will take about one hour for every 50 deg. increase, and therefore an increase of 300 deg. will occupy about six hours. By the time it reaches 750 deg. C. I consider it has been sufficiently stripped of its nitrogen to make any further loss negligible.

The ammonia results are, unfortunately, for a variety of reasons, perhaps the least accurate: this side of the problem has not yet received the amount of attention which its importance merits.

My first experiments were with a cannel coal from Ayrshire. This gave approximately 40 lb. of sulphate of ammonia per ton. The next coal tested was also a cannel, this time from Lanarkshire, and this, by determining the time to neutralise a carboy of acid, showed 63 lb. to the ton. The next tests were on Cadder coking coal, while running for smokeless fuel. As the oil and liquor could not be separated, no actual estimate was taken, but tests of the ammonia in the gas gave very low results. The coke in this case had very often a highly-glazed surface skin and probably did not allow of free access of the combustion gases to its centre.

The results with Greenhill coal, working for power-gas, were better, one result showing 36 lb. and the one following 49 lb., as measured by the acid neutralised. In steady running these yields are likely to be exceeded, as on beginning the experimental test showing 36 lb. the fuel in the producer, at the start, had been much more completely denuded of its nitrogen than the fuel remaining in the producer at the end of the test. The cooling and scrubbing plant consisted of the two scrubbers already referred to, and as acid only passed through the first scrubber, any ammonia passing to the second scrubber was entirely omitted. The amount of ammonia escaping would not be very great, our experience being that so long as the rate of gas passage did not exceed 50,000 cub. ft. per hour, little ammonia was carried forward.

Regarding the commercial side of the process, it is impossible to speak definitely until the market value of the oil products has been ascertained, but 2*d.* per gallon for the crude oil should make it worth considering in most situations. The capital cost before the war of a plant capable of handling 20 tons of coal per day amounted to about 1,000*l.*, exclusive of coal crushers, elevators, and driving engine.

The yields of all the products have been equal to my anticipations for the coals concerned, except illuminating gas, which has been a complete disappointment, though the enhanced value of the oils may be found more than to counterbalance this.

Approximate yields for the kinds of coal handled are given below.

Working for Smokeless Fuel.—Gas, 10,000 cub. ft. per ton, 330 British thermal units. Oil, 16 gallons (7 per cent.). Liquor, 12 per cent. Smokeless fuel (5 per cent. volatile), 65 per cent.

Coking Coal.—Gas, 144,000 cub. ft. per ton, 112 British thermal units. Oil, 16 gallons. Sulphate of ammonia, 45 lb. Energy loss, 6,250,000 British thermal units per ton.

Cannel Coal.—Gas, 80,000 cub. ft., 114 British thermal units. Oil, 32 gallons. Sulphate of ammonia, 36 lb. Energy loss, 4,750,000 British thermal units per ton.

The energy losses will probably be reduced as experience grows. The low capital cost of the plant is largely due to the gases leaving the producer comparatively cool, hence reducing the condensing power to a minimum. The small amount of steam necessary makes a great saving in working costs and condensing plant. The most interesting results from the chemical sides are:—

1. The small quantity of hot gas required to carbonise a ton of coal.
2. The small percentage of light olefines present in the gas.
3. The relative absence of light portions—benzene homologues, carbolic and cresylic acids—in the crude oil.
4. The presence of resinous substances in the oil.
5. The lubricating quality of the non-resinous oil.
6. The drying properties of the crude oil.
7. The presence of dyes in the ammonia liquor and the oil.

Further investigation of these various products is likely to prove fruitful commercially, and highly interesting.

In conclusion, the author desires to express his thanks to those who have assisted him, especially to the Corporation of Glasgow and to Mr. Hardie, upon whom a great deal of the work has devolved.

REFINING HOT STEEL IN THE ELECTRIC FURNACE.—We read in *The Iron Age* that the duplexing of hot metal from open-hearth into electric furnaces will soon be the practice of the Charleston Steel Company, Belle, W. Va. The company has nearly completed one 8-ton open-hearth furnace, which will be delivering hot metal to the electric furnaces in a few weeks. A 15-ton open-hearth furnace will also be erected. The Rennerfelt electric furnaces originally installed at this plant have been modified by introducing the three electrodes through the roof.

EYE PROTECTION.—The Seaman gold medal, the gift of Dr. L. L. Seaman, which is awarded every year by the American Museum of Safety, for the promotion of hygiene and the mitigation of occupational disease, has this year been conferred upon the Julius King Optical Company, of New York, for their appliances against the dangers of ultra-violet and infra-red light. *The Journal of Industrial and Engineering Chemistry*, of July, 1917, from which we quote, does not say what the safety glasses are made of. The firm recommends for workers in furnace-rooms, &c., a helmet of fibre, provided with a fireproof cap on the top; the helmet proper is pivoted to this top. The eye lenses are made of "akopos" glass (for gas-heating furnaces, &c., at temperatures near 2,000 deg. F.), light or dark "sani-weld" glass (for temperatures up to 3,500 deg. or 4,300 deg.), for acetylene welding and cutting, pouring steel, &c., and "ark-weld" glass (combined with the other glasses to eliminate infra-red rays, for the temperatures up to 6,000 deg. of the electric arc); the helmet is, in general, to prevent face and neck-burning. The firm rejects the much-used cobalt glass as positively bad.

CATALOGUES.

Steel Shelving.—Steel shelving, bins, counters, cabinets and racks in many convenient forms are illustrated in a circular which comes from the makers, Messrs. Joseph Sankey and Sons, Limited, Hadley Castle Works, Wellington, Shropshire.

Centrifugal Pumps.—A small folder catalogue showing a range of pumps has been issued by Messrs. Holden and Brooke, Limited, Sirius Works, West Gorton, Manchester. They include: a six-stage pump for lifts up to 1,500 ft., directly driven by an A.C. motor, both being mounted on one baseplate; a single stage pump and motor on one baseplate and a similar arrangement on a four-wheeled truck. Another range of one- and two-stage pumps for belt drive is also shown, and a series of steam fittings—injectors, ejectors, feed-water heaters, oil separators and traps for steam and vacuum.

Steam Valves and Traps.—The Engineering Specialties Company, Thompson Place Iron Works, Belfast, send a leaflet catalogue of four steam fittings:—(1) The "steam boiling valve," for vats, keirs and similar closed vessels, has a deadweight equilibrium action, which admits up to full boiler pressure until the heat, or corresponding pressure, for which it is weighted is attained; it then cuts off the major pressure and maintains the required pressure by continual automatic readjustment. (2) The expansion trap for draining steam fittings remains open as long as water is against its expander piece, and closes when steam strikes this piece. (3) The bucket steam trap gives an intermittent discharge of water and closes against steam, and is fitted with an air discharge valve and blow-off pedal. (4) The pressure reducing valve maintains a set reduced pressure against a variable boiler pressure. The stock sizes are from ¼ in. to 3 in. for (2) and (3), with screwed inlets and outlets, and for (1) and (4) ¼ in. to 6 in., with a choice of screwed and flanged ends.

Bronze.—The term "gun-metal" had two well understood meanings a few years ago—a strictly defined casting mixture when specified, or an approximately similar mixture when the term was used without a specification. It is now dangerous to use the term unless the piece to be made really requires strict Admiralty mixture. For, say, a slow bearing, where a non-rusting metal is all that is really necessary, but something better than yellow brass is preferred, it is becoming usual to specify bronze. Bronze is a less strictly defined mixture. A trade catalogue issued by the American Brass Company, of Arizona, Conn., U.S.A., gives some useful information about "Tobin" bronze. It consists of 59 per cent. to 63 per cent. copper, 0.5 per cent. to 1.5 per cent. tin, the balance mainly spelter, and contains no aluminium, manganese, iron or lead. The weight is 0.3215 lb. per cub. in. and the melting-point 1,600 deg. F. Tables are given of weights in pounds per foot length for rounds and hexagons ¼ in. to 5½ in. diameter, and sheets $\frac{1}{32}$ in. to 1½ in. thickness. There are also tables of torsional, crushing and corrosion tests, which show good results. The metal may be forged, stamped or drop-forged, if worked carefully and only at a cherry-red heat, and is claimed to be suitable for pump rods, bolts (on which the head may be forged) and tubes and sheets for condensers.

Excavating Machines.—For some time the only buyers of machines for digging and lifting earth material were the most enterprising of the contractors in railway, canal and dock making. Now the machines are to be found at pit-heads, quarries, brickfields, iron and steel works, coal stacks and many similar places. A catalogue issued recently by Messrs. Ruston, Proctor and Co., Limited, Lincoln, gives a great deal of useful information about these machines in its 100 pages of excellent illustrations and carefully stated facts. Three or four types, weighing from 20 tons to 80 tons, and all steam driven, are in general use, in addition to many specially designed for particular work. The cost of the machine—including capital and maintenance—is about one-third to one-half of 1*d.* per ton of material dug and tipped into wagons; the lowest cost being about ½*d.* per ton for sand and the highest ¾*d.* per ton for ironstone. The general economy and scale of work is fairly indicated by an instance in which a light machine is digging and filling into trucks the quantity of hard clay required to make 400,000 bricks per week at a cost of 5*d.* to 6*d.* per ton for machine, fuel and labour, as compared with 16*d.* per ton for the same work done by labour without the help of machinery. These statements are merely a rough summary of many precise tables of figures given in the catalogue. Messrs. Ruston, Proctor and Co. have made these machines for over forty years, and a few years ago incorporated in this branch of their business the drawings, patterns, templates and patents of similar machines by Whittaker Brothers, Limited, of Leeds. In later types transporting mechanism is added.

DECALESCENCE-POINT FINDER FOR HARDENING STEEL.—The Slocum, Avram and Slocum Laboratories, New York City, manufacture a decalescence-point finder for use in hardening steels, says *American Machinist*. It consists of a magnet of compact form, balanced in a brass arm to allow the attraction due to the magnetic force to be shown, up to the time the decalescence-point is reached. When this happens, the steel being treated loses its power of magnetic attraction, but regains it again when a temperature of from 75 deg. to 100 deg. F. above this point is attained. The steel being hardened should be quenched at the point where it becomes non-magnetic. The instrument can be adapted for use with the various types of furnaces.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACT OF 1907.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics.

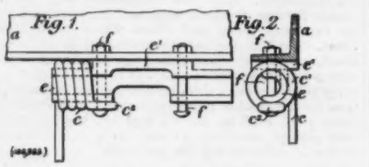
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 6d.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any grounds mentioned in the Act.

AGRICULTURAL APPLIANCES.

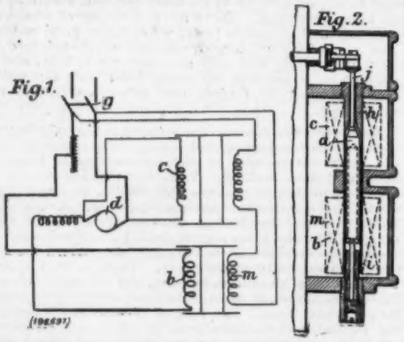
106,985. W. E. Martin, Stamford. Tines. (7 *Figs.*) July 13, 1916.—The invention relates to that type of rake in which each tine is bent into the form of a spiral spring at its upper end and the end of the spiral spring is formed into a ring or eye. *a* is the rake head, and *c*, *c* are the tines. The carriers for the tines *c* each have two cylindrical or semi-cylindrical ends *e* to receive the coiled ends c^1 of the tines *c*, and the central portion of the carrier may be in the form of a plate e^1 having



two holes to receive bolts *f*, *f* passing through the rake head *a*. These bolts *f*, *f* not only attach the carrier *e*, e^1 to the rake head *a*, but also, by passing through the rings c^2 on the coiled ends c^1 of the tines *c*, act to secure these latter on the carrier *e*, e^1. By detaching one bolt *f*, the carrier *e*, e^1 may be turned on the other bolt *f* and a new tine *c* may be placed in position, after which the carrier is turned into its original position and is again secured by the second bolt *f*. Each carrier *e*, e^1 may, however, carry but one tine *c*, and be fixed by a single bolt *f*. (*Accepted June* 20, 1917.)

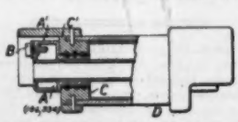
ELECTRICAL APPARATUS.

106,697. G. Ellison and J. Anderson, Birmingham. Dynamo-Electric Machines. (2 *Figs.*) June 21, 1916.—This invention relates to protective devices for dynamo-electric motors, and comprises the employment of a solenoid plunger arranged to actuate the trip of a circuit-breaker and to be under the opposed controls of a pair of magnetic fields, one produced by a coil in series with the armature and the other by a coil in shunt with the armature, and an additional coil of constant



ampere turns assisting the series coil. The plunger *a* is situated within coils *b*, *c*, respectively connected in series and in shunt with the motor armature *d*. At each end of the plunger is a fixed core *h*, *i*, and through *h* passes a brass rod *j*, by which motion is transmitted to the trip of the circuit-breaker *g*. In conjunction with the series coil *b* is provided another coil *m* connected in shunt with any convenient part of the system of constant voltage. The ampere turns of this coil must be constant, or practically so, for a given adjustment. (*Accepted June* 13, 1917.)

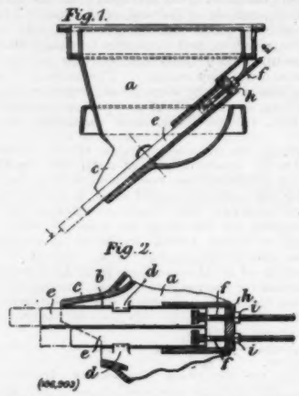
106,934. Mavor and Coulson, Limited, and W. Lawrence, Mile End, Glasgow. Fusible Electric Cut-Outs. (5 *Figs.*) October 23, 1916.—This invention refers to carriers for fusible electric cut-outs of the type wherein the fusewire is connected at its ends to two conductor heads separated and insulated from one another, associated with an intervening tubular part through which the fusewire, when in position, extends, such carriers being formed so as to be conveniently grasped by the hand to



facilitate their being placed into and withdrawn from position. According to this invention, the conductor heads are each fitted with porcelain insulation parts, and the carrier comprises these, associated with a protective outer casing composed of fibrous substance. The conductor heads are each formed with a longitudinal circular bore, and, concentric to the bore, there is a cylindrical sleeve portion A, and at the outer end an enlarged shoulder part A^1, to which one end of the fusewire is adapted to be connected, by means of a terminal screw B and washer. The sleeve A and shoulder part A^1 constitute the conductor head. Surrounding the sleeve portion A there is mounted a circular porcelain collar C having at its outer end a cylindrical peripheral rim C^1 of a diameter corresponding to the outer diameter of a tubular casing D composed of a fibrous substance, and from the rim C^1 to the inner end of the collar C the periphery is cylindrical and of a diameter suitable to fit into the end of the tubular casing D. (*Accepted June* 20, 1917.)

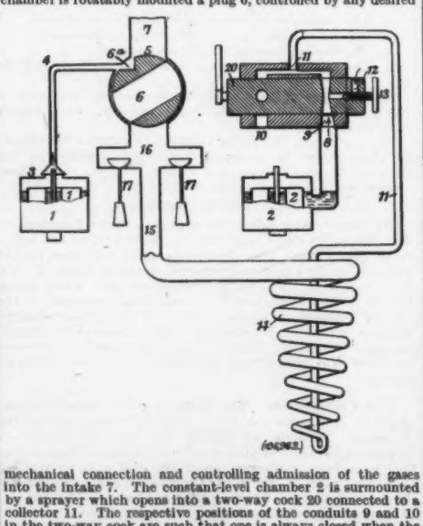
GAS ENGINES, PRODUCERS, HOLDERS, &c.

106,943. The International Construction Company, Limited, and A. Sahlin, London. Gas Producers. (3 *Figs.*) November 10, 1916.—This invention relates to feeding mechanism for shaft furnaces, such as gas producers, in which a nozzle for feeding or distributing the charge projects into the furnace. The invention provides means for renewing or adjusting the shape of the nozzle from time to time, without interrupting the operation of the producer or furnace. The spout or funnel *a* is provided with a longitudinal groove *b* in line with the nozzle *c*,



such groove receiving two slidable bars *e*, *e* of iron or steel side by side, held therein by lugs *d*, and which bars can be moved out and in so that they extend a longer or shorter distance beyond the nose of the nozzle. The bars are held and operated from their upper ends independently by T-headed and screwed bolts *f* loosely engaging them, and passing through an end-cover or yoke-piece *h*, carried by the spout or funnel, which affords a bearing for nuts *i*, *i* engaging the screwed ends of the bolts, and by which they may be allowed to move outwardly to advance the bars as they are consumed. (*Accepted June* 20, 1917.)

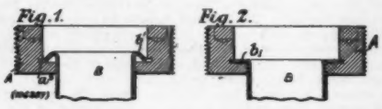
106,963. J. De Ferry, Paris, France. Internal-Combustion Engines. (1 *Fig.*) October 14, 1916.—This invention relates to a process which renders it possible in explosion engines to employ petrol in starting the engine, and then to introduce heavy oils. The process consists in obtaining an explosive gas mixture, with petrol and with heavy oil, in two circuits independent of each other, with constant level vessels, connected to the intake of the engine. A plug is used whereby connection can be made at will to one or the other circuit, and the partial vacuum due to the suction of the engine atomises the heavy oil in a tapered passage. Gasification is effected in a coiled tube and an additional quantity of air is admitted before the mixture reaches the intake. 1 and 2 are constant-level vessels, 1 being supplied with petrol and 2 with heavy oil, &c. 3 is an ordinary sprayer opening below a pipe which terminates at the upper portion of the carburettor chamber. In the said chamber is rotatably mounted a plug 6, controlled by any desired



mechanical connection and controlling admission of the gases into the intake 7. The constant-level chamber 2 is surmounted by a sprayer which opens into a two-way cock 20 connected to a collector 11. The respective positions of the conduits 9 and 10 in the two-way cock are such that one is always closed when the other is open, and *vice versa*. By rotating the cock 20 the pipe 8 can be connected to feed into 9, or the opening 10 can be made to connect with the atmosphere. In the axis of the plug of the cock is provided an air supply conduit 12 leading to the conduit 9, and adjustable by means of a screw needle valve. The collector 11 is connected directly to the heating coil 14, located in the exhaust pipe of the engine, the dimensions of the said coil depending on the power of the engine and being such as to ensure complete gasification. This heater is shaped as a helically coiled tube, in which the diameter of the spirals and the diameter of the tube increase from the bottom of the top of the cone. The heating coil 14 terminates directly in the pipe 15 of the carburettor, below the plug 6 in the chamber 16, in which are arranged automatic valves 17. The working of the apparatus is as follows: When the engine is started, the plug 6 being in the dead slow position, and the cock of the constant-level vessel 2 being in the position establishing communication between 10 and 11 (that is to say, at an angle of 90 deg. to that shown in the drawing), the engine will draw petrol into the carburettor. The plug 6, in this position, admits additional air required for the combustion of the petrol, through the circuit 10—11—14—15—16—7. As the air passes through the heater it heats the chambers 15, 16 of the carburettor. The cock of the constant-level vessel 2 is then turned into the position establishing communication between 8 and 11 (position shown in the drawing). The suction in the circuit 16—15—14—11—9 being then very slight, air will continue to flow in through the conduit 12, without carrying with it the heavy oil. As soon as the plug 6 is turned, the admission of petrol through the circuit 1—3—4 is closed, and the circuit 12—9—11—14—15—16—7 is opened. The suction being much stronger, the tapered passage 9 becomes filled with heavy oil, &c., in a vaporised condition, which is then gasified at 14 and arrives at the engine through the circuit indicated, the quantity of air admitted through 12 being sufficient for ensuring its combustion. If the turning of the plug 6 is continued, the suction constantly increasing, the vaporisation in the passage 9 becomes stronger and stronger. The valves 17 are set so as to admit additional air as required for complete combustion of the mixture. In this device the plug 6, on the two distinct gas circuits, controls the admission of the explosive gaseous mixture, and not only the admission of the additional air or of the heated gas. (*Accepted June* 20, 1917.)

GUNS AND EXPLOSIVES.

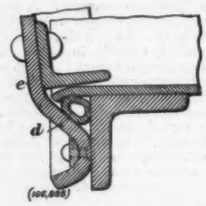
106,837. The Lancashire Dynamo and Motor Company, Limited, Trafford Park, Manchester, A. P. Wood, Hale, Cheshire, and J. R. Garner, Stretford, Lancashire. High Explosive Shells. (5 *Figs.*) March 15, 1916.—This invention relates to high explosive shells and has reference to the mode in which the open end of the exploder container is attached to and makes joint with the adapter. According to the usual practice the exploder container is secured to the adapter by



brazing; this process is costly, and the necessity for removing the unutilised materials employed in brazing renders it a slow one, thus causing delay in production. According to the present invention, the open end of the exploder container B is so flanged at b^1, and the bore of the adapter A is so recessed at a^2 and shaped that an effective attachment and joint between them is effected by the action of a die subjected to pressure, which forces the flange b^1 into the recess a^2 (Fig. 2). (*Accepted June* 20, 1917.)

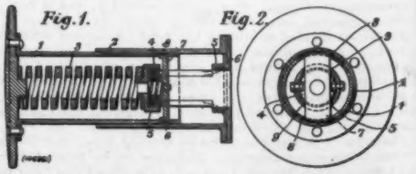
RAILWAYS AND TRAMWAYS.

106,885. The Leeds Forge Company, Limited, and R. G. Sharp, Leeds. Tank Wagons. (3 *Figs.*) June 26, 1916.—This invention has reference to covers or doors of tank wagons. In a tank wagon provided with a cover or door and an endless jointing ring of india-rubber or similar flexible tube arranged between the cover or door and adjacent part of the vessel, the said parts are so constructed that when the cover or door *c* is in the closed position the tube *d* is located in a chamber



of approximately triangular cross-section extending around the opening to be closed, one wall of such chamber being formed by the suitably shaped marginal portion of the door, the arrangement being such that when the cover or door is secured in its closed position the said wall formed by the marginal portion thereof will cause pressure to be applied to the ring or equivalent along lines corresponding to not less than three points on the circumference of the tube sufficient to deform the tube and keep it in close contact with the cover or door and the part of the vessel around the opening. (*Accepted June* 20, 1917.)

106,961. C. Watson, Ealing, London. Buffers. (3 *Figs.*) January 18, 1917.—This invention relates to buffers of the self-contained type for railway and other rolling-stock. The buffer shown consists of the usual plunger 1, carrying the buffer head, adapted to slide within the casing 2, and a buffing spring 3 and recoil spring 4. The separation of the springs is effected by the internally-projecting socket 5, the base 6 of which is connected to the casing base in some suitable way. The inner end of this socket 5 forms one abutment for the spring 3 and one abutment for the spring 4, which is located



inside and at the inner end of the socket, while the movable plate 7 forms the other abutment for spring 4. This plate is confined at its ends in short slots 8, 8 in the plunger 1, and passes through longer slots 9, 9 in the socket, being prevented from escaping by contact of the ends with the casing 2. In operation, the pressure-effect upon the buffer head and plunger compresses the spring 3 against the head of the socket 5 and carries the plate 7 rearwardly along the slots 9, such plate following the plunger back on its return movement and receiving the recoil of the spring 4, which had expanded on the retreat of the plate 7. (*Accepted June* 20, 1917.)